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ABSTRACT

The implementation and evaluation of a project at Xavier University of Louisiana that was designed to increase performance and academic persistence in entry-level mathematics and science courses are described. The University's CAUSE Project was a cooperative effort by the departments of biology, chemistry, mathematics, and physics. Strategies of the project were to: develop a mechanism whereby the department assumed responsibility for choosing content and deciding pacing for entry-level courses; develop detailed prescriptions for and administer final exams to assess progress from year to year; and develop a set of alternate pathways for learning content objectives. Each of four departments have developed and refined student handbooks containing content objectives, related sample problems, and a list of alternate learning aids for each topic; developed common final course examinations; developed and field tested at least five Piagetian-based laboratory experiments designed to promote analytical thinking skills; and jointly planned, renovated, and furnished a multidepartmental Alternate Pathway Learning Center. Among the results of the project are that the chemistry and physics departments increased the percentage of students completing both semesters with a grade C or better. Results for the other departments are also presented. A detailed outline of implementation activities and extensive appended materials on the project are included. (SW)

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Final Report for CAUSE Grant SER77-06227

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STANDARDS WITH SYMPATHY APPLIED: An Executive Summary of CAUSE Grant SER77-06227

OVERVIEW: Xavier University of Louisiana is a small, predominantly-Black institution located in the heart of New Orleans. The University has both a strong commitment to a liberal arts education and to increasing the number of Black Americans who obtain careers in science-related fields. Over the past two years approximately 140 students have gained admission into natural science-related graduate or professional schools. In the fall of 1980, more than 900 of the approximately 2000 students at Xavier were majoring in a mathematical, natural, or health science. This is 50% higher than the enrollment in these fields four years ago. A major factor in XU's success in providing Black Americans access to science-related fields has been the University's commitment to an institutional philosophy of "standards with sympathy"--coupling high academic expectations with mechanisms which allow disadvantaged students to attain success.

XU's CAUSE Project was a direct extension of the philosophy of "standards with sympathy." Its primary objective was to increase performance in and reduce attrition from entry-level mathematics and science courses so as to maximize the number of students who graduate in the sciences. The project was conceived and implemented as a cooperative, multidisciplinary effort by the Departments of Biology, Chemistry, Mathematics, and Physics. The basic strategies chose to achieve the stated objective were for the four departments to work cooperatively so each could

1) develop a mechanism whereby the entire department, not individual instructors, assumed responsibility for choosing content and deciding appropriate pacing for entry-level courses,

2) develop detailed prescriptions for and administer common final exams so as to improve ability to determine success in transmitting prespecified content from year to year, and

3) develop a comprehensive set of "alternate pathways for learning" each set of content objectives in each entry-level course and to establish a joint facility (the Alternate Pathway Learning Center--APLC) for using alternate pathways.

This particular approach was chosen because a) it increases the ability of the departments to provide assistance to inexperienced faculty, b) adherence to a common content framework makes it possible to establish cooperatively (within a department) a much more extensive system of "alternate pathways" than any one faculty member could support alone, and c) a joint, multi-departmental approach to development makes it possible to implement and sustain activities at the least possible cost.

(over)

SUMMARY OF ACTIVITIES COMPLETED: Xavier's CAUSE Project progressed extremely well with only minor deviation from the development outlined in the original proposal. Each of the four departments have:

...Developed, field-tested, evaluated, modified, refined, etc. "handbooks" for use by students in each of the entry-level courses for science majors at Xavier. The handbooks contain the departmentally-specified content objectives, related sample problems and/or tests, and a list of alternate learning aids for each topic.

...Designed and begun to administer common final examinations in each section of each course every semester.

...Developed and field-tested a minimum of five Piagetian-based laboratory experiments designed to promote analytical thinking skills. In addition, Chemistry has developed an entire two-semester sequence of such experiments and now uses them for all general chemistry courses.

...Jointly planned, renovated, and furnished a multi-departmental Alternate Pathway Learning Center (APLC) a semester ahead of schedule.

PROGRESS IN ACHIEVING STATED OBJECTIVE: The modification of entry-level course and development of the APLC has resulted in signficant progress in obtaining the stated objectives of reducing attrition from and improving performance in entry-level mathematics and natural science courses for science majors as noted:

...Biology increased the percentage of "off-semester" students who successfully completed Biology 123-124 from 25% to 50% as a result of CAUSE. In addition, there was a 24 percentile increase in performance on the CLEP General Biology Exam.

...Chemistry increased the percentage of students completing the first semester of general chemistry with a "C" or better from 60% to 74% and increased percentage completing both semesters with a "C" or better from 45% to an average of 58% while, at the same time, increasing level of performance on finals in both semesters.

...Mathematics increased the percentage of students completing both Precalculus and Calculus I with a "C" or better while noting slight increases in level of performance.

...Physics increased the percentage of students completing both semesters of Physics with a "C" or better from 53% before CAUSE to an average of 75.5% after CAUSE while, at the same time, increasing the level of performance on the second semester final from an average of 51 to 63.

In addition to obtaining the specific objectives of increasing performance in and reducing attrition from entry-level biology, chemistry, mathematics, and physics courses for science majors, XU's CAUSE Grant also significantly increased the ability of the four departments to evaluate their programs from year to year. Each department now administers common final exams written from departmentally-prepared "prescriptions" and has implemented systematic collection and comparison of performance from year to year for evaluation purposes.

For additional information, contact JW Carmichael, Director, CAUSE Project SER77-06227. Prepared 12/15/80.

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I. Overview of Xavier University of Louisiana

Xavier University of Louisiana is a small, predominantly Black institution located in the approximate geographic center of the city of New Orleans. In the fall of 1980, its total enrollment is the largest ever--2,003--of which approximately 925 students are natural, health or mathematical science majors (see Appendix I for enrollment statistics for the past eleven years). The University's primary mission is to provide educational opportunities to Black Americans with emphasis on residents of the Gulf South. Xavier's institutional philosophy might be summarized as "standards with sympathy"--a commitment to accept appreciable percentages of students with discernible academic weaknesses, coupled with an equally strong commitment to demand a high standard of performance for graduation. It is possible to do both simultaneously only because the University provides extensive support services, especially at the freshman level.

Xavier's past performance is best exemplified by the outstanding success of its alumni who include:

> The Honorable Ernest "Dutch" Morial, Mayor of the City of New Orleans the first Black American to be elected to that position.
>
> Ms. Mary Munson Runge, President of the American Pharmaceutical Association, the first Black and first female to hold that position and member of President-Elect Reagan's Advisory Committee for Science and Health.
>
> Mr. Joseph Hall, President of the National Pharmaceutical Association. (With Mr. Hall's election, Xavier became the only institution to have alumni simultaneously serve as presidents of the two major pharmaceutical associations.)
>
> Dr. Claude Organ, M.D., Chairman and Professor of the Department of Surgery at Creighton Medical School.
>
> Dr. Joseph Henry, Jr., D.D.S., Associate Dean, Harvard School of Dental Medicine, the first black to hold such a position at Harvard.
>
> Dr. Norman C. Francis, President of Xavier University, President (1980) of the Soutern Association of Colleges and Schools, Past-President of the College Entrance Examination Board, Member of the Pontifical Commission on Justice and Peace, and Member of President Carter's Advisory Committee for HEW.

The extent to which the sciences continue the University's record of achievement is indicated by the following representative statistics from more recent years:

1. In the past six years, 85 of 100 XU students who applied to medical or dental school gained admission. This acceptance rate, 85%, is more than twice that national average for either minority or majority students during that period.

2. During the past two years alone (1978-79 + 1979-80), Xavier placed approximately 125 students into medical, dental, pharmacy, or science-graduate schools. Further, the students gained admission into some of the nation's most prestigious schools including Harvard Medical School, Stanford Medical School, University of California--San Francisco Medical School, Tulane Medical School, etc.

3. Xavier's College of Pharmacy is the only such facility in southern Louisiana. Over the past three years (the only ones during which the State has provided comprehensive feedback), XU graduates have a higher pass rate on the Board than do non-XU graduates.

4. In 1977-78, a Chemistry graduate from Xavier was the only student from a Louisiana institution to receive a prestigious Danforth Fellowship for graduate study.

II. Overview of the Progress of XU's CAUSE Grant

Specific Objectives:

CAUSE Grant SER77-06227 to Xavier University of Louisiana funded a multi-departmental effort by Biology, Chemistry, Mathematics, and Physics to further develop the entry-level science and mathematics courses for science majors in an effort to make science careers more accessible to the minority students whom Xavier serves. The specific objectives of the grant were:

1. To reduce attrition from entry-level mathematics and natural science courses for science majors.

2. To increase the level of performance by students in those same courses.

3. To develop mechanisms for each department to use in objectively comparing level of performance of students in entry-level courses from year to year.

Basic Thrust:

The basic thrust of the CAUSE Grant at Xavier was to develop "departmental" entry-level courses which would make it possible to:

1. More objectively compare student performance from year to year.

2. Provide better and more specific assistance to new or part-time faculty.

3. Establish a uniform educational base on which upper-level instruction could be developed.

4. Provide a common framework for instruction so as to facilitate the use of alternate pathways for learning with emphasis on those beneficial to the educationally-disadvantaged.

Premises:

As a framework within which to cast anticipated curriculum development, each of the four participating departments agreed to a basic set of premises before initiating the CAUSE proposal. They were:

1. A department, not an individual instructor, should determine the content of entry-level courses.

2. It is possible to integrate activities to assist the educationally disadvantaged within regular entry-level courses without adversely affecting quality of instruction--i.e., "sympathy" and "standards" are not incompatible.

3. All development must occur within the context of the University as a whole with particular emphasis on constant consideration of what Xavier can afford to support financially after the grant period.

4. Evaluation must be a constant and ongoing part of the project if it is to gain true departmental acceptance and have long lasting impact.

5. A cooperative, multi-departmental effort is most likely to have the desired impact on entry-level courses because this approach allows departments to benefit from each other's experiences and promotes the development of activities across departmental lines which will be academically reinforcing.

Historical Development

The CAUSE Project at Xavier was a direct outgrowth of a systematic consideration of what had been successful in the individual departments in the past and a commitment to well-defined departmental goals to improve entry-level courses as a means of increasing the number of Black Americans graduating in science-related fields.

Planning for the activities undertaken in the CAUSE Grant began in the spring of 1976 when representatives from the entire Division of Natural Sciences met at the request of the University Dean, Sr. Mary Veronica Drawe, to review past efforts to improve education in the entry-level courses in the Division and to discuss future plans for doing so. As a result of that meeting, each department appointed a representative to a committee empowered to a) review the past efforts at Xavier and elsewhere in more detail, b) make recommendations for future development, and c) pending approval by the participating departments, seek funds to implement the development needed.

In subsequent meetings in the spring of 1976, the committee determined that first efforts should be directed toward a) investigating new ways of improving problem-solving skills with emphasis on Piagetian-based activities, b) mutual auditing of each of the entry-level courses so that the representatives could determine extent of overlap and areas where cooperation was likely to be possible, and c) establishing a mechanism for meeting on a regular basis for considering further developments.

During 1976-77, the same committee a) audited each other's courses, b) met on a regular weekly basis for one hour to develop the ideas which they eventually wrote into the CAUSE proposal, c) began efforts to develop Piagetian-based materials, and d) conducted the first of a series of special summer programs which function, to a large degree, as a place where new ideas can be tested without the content and grade constraints of the academic year.

In summary, the CAUSE Project at Xavier was a direct outgrowth of extensive planning and past development at the University on the part of the faculty within the departments to whom the grant was awarded.

Management:

The CAUSE Project at Xavier was implemented by the "CAUSE Committee". The initial members of the committee were the same group of faculty, one from each of the participating departments and a director, who had completed the previous planning and had written the proposal. Subsequent efforts to expand the membership of the committee in an effort to ensure that development was truly

departmental were extremely successful. Two other faculty voluntarily joined the committee even though doing so meant an extra one-hour weekly meeting, six became sufficiently involved so as to assume, for all practical purposes, "associate membership," and essentially all of the remainder of the faculty in the departments (approximately 12) were actively involved in the development and evaluation a number of times. Of particular note was the successful integration of new faculty into the project as the were hired by the University. The following lists the membership of the CAUSE Committee during the grant period:

Original Representatives: Jacqueline Hunter, (Biology), Mary Ann Ryan (Chemistry,) Lester W. Jones (Mathematics), Harold Vincent (Physics), and JW Carmichael, Jr. (Director, Chemistry)

Voluntary Additions: Sr. Grace Mary Flickinger (Biology), Bill Irlbeck (Mathematics), and Sr. Joanne Bauer (Chemistry)

Associate Members: Deidre Labat (Biology), Donald Robinson (Chemistry), Sr. Rosemarie Kleinhaus (Mathematics), Winston Brown (Mathematics), and Douglas Ruby (Biology)

Specific Accomplishments

Xavier's CAUSE Project progressed extremely well with very little deviation from the proposed developed outlined in the original proposal. The specific accomplishments of the grant were as follows:

1. All four departments specified content objectives for both semesters of the entry-level lecture courses for science majors (Biology 123 & 124, Chemistry 101 & 102, Mathematics 103 & 104, and Physics 201 & 202). Development has been particularly significant in Biology and Mathematics. Biology chose this opportunity to initiate an entire year of introductory general biology to replace a semester of general biology and a semester of zoology. Mathematics, in an equally important move, modified Pre-Calculus (Mathematics 103) so as to greatly increase emphasis on practical skills and developed a completely new survey of Calculus (Mathematics 104) designed to serve as either a terminal course for those students who need only one semester or the first semester of a three-semester sequence for those who need more Calculus.

2. All four departments developed, field-tested, evaluated (by departmental, divisional, and outside consultants), modified, etc. "handbooks" for use by students in each course. The handbooks contain the content objectives, sample problems and/or tests, references to alternate pathways for learning, etc. The materials are used by all faculty teaching in a given course and are available in the University bookstore at a fee only slightly above cost so that each student has an individual copy without placing undue financial strain on the University.

3. All four departments completed development of specifications for the finals in their respective entry-level sequences and Biology, Chemistry, and Mathematics have found standardized exams to use so that student performance from year to year can be more easily compared in the future.

4. All four departments developed and field-tests a minimum of five Piagetian-based laboratory experiments designed to promote analytical thinking skills. Chemistry further developed an entire two-semester sequence of such materials and now uses the experiments in its general chemistry laboratory courses. Biology and Physics have developed approximately ten such experiments each and are field-testing them in entry-level courses at present.

5. Representatives from all four departments attended a series of "hands-on" workshops designed to acquaint the faculty with the Tektronix and Apple II computers available and to provide the opportunity for discussion of their use in entry-level courses. Mathematics and Physics have now integrated their use into their courses to some extent.

6. The departments planned, renovated, and furnished a multi-departmental Alternate Pathways Learning Center (APLC) an entire semester ahead of schedule. Further, the facility, which is located in the University Library, has enjoyed overwhelming popularity. It averages more than 12,000 entries per month (an actual head-count by electronic means). A permanent University Committee consisting of one representative from each department, the Director of the Library, and the University Dean has been established to oversee usage of the area in the future. As indicated by its name, the facility serves primarily as a base for offering "alternate pathways" (to lecture and text) for learning.

7. Each department had its progress reviewed by an outside consultant during each of the first two years of the grant and there was an overall evaluation of the project by an outside consultant in the third year.

8. Finally, and undoubtedly most important from the point of view of long-term impact of the project, constant formative evaluation was used to gain wide support for the project throughout the entire Division of Natural Sciences. This was accomplished via s series of workshops to which all members of the Division were invited (with University-funded refreshments as an incentive to attend), weekly meetings of the CAUSE Committee, interminable departmental meetings to discuss content and teaching approaches, a great deal of hard work on the part of the departmental representatives, and a faculty who are very receptive to new ideas if the have potential for helping students.

III. Detailed Description of the Implementation of XU's CAUSE Project

The four participating departments agreed upon a general plan for development before beginning the project and continually worked, through the CAUSE Committee, to exchange ideas and implement activities jointly as much as possible since receiving the CAUSE Grant. However, because the different departments had had differing opportunities to undertake course development in the past, the various components of the CAUSE Project were implemented at varying rates by the departments over the grant period. The specific activities instituted, both intra- and inter-departmentally, are listed on the following pages in chronological order.

Activities of a General Nature Implemented Via CAUSE:

The CAUSE Committee met regularly for a minimum of one-hour per week during the entire grant period to discuss implementation of the project and to plan joint activities. In addition, the same committee had met in the same manner for the entire year preceding the awarding of the grant. Because of this continued close association over a long period of time, the committee was extremely successful both in communicating what was happening within a given department and in conducting joint activities. In addition to the weekly meetings, the committee also sponsored the following joint activities during the grant period.

Summer, 1977	CAUSE Grant Awarded
Fall, 1977	Representatives from Biology, Chemistry, Mathematics, and Physics met with the University Dean and the Director of the Library to work out details for the renovation and subsequent use of the new, combined learning center for the sciences, the APLC (Alternate Pathways Learning Center). A permanent committee was appointed to shepherd the development of the center. It consisted of one representative from each of the four departments, the University Dean, and the Director of the Library. In addition, the Director of the CAUSE Grant served on the committee temporarily until the facility actually opened. The members of the APLC Committee were: Sr. Grace Mary Flickinger (Biology), Dr. Mary Ann Ryan (Chemistry), Mr. Winston Brown (Mathematics), Dr. Harold Vincent (Physics), Mr. Lester Morris (Director of the Library), and Sr. Mary Veronica Drawe (University Dean). The committee was chaired by Dr. Carmichael, temporary member as director of the grant, until the opening of the APLC in the spring of 1979. At that time, he resigned from the committee and Sr. Grace Mary Flickinger assumed chairmanship. The committee met regularly during the past two years as the space was renovated, furnished, and ultimately used in the spring of 1979.
Fall, 1977	Dr. Carmichael attended a CAUSE Director's Meeting sponsored by NSF in Washington. The meeting provided the opportunity to discuss various components of XU's project with directors from projects awarded the previous year.

Fall, 1977	The CAUSE Committee sponsored a PSI (Personalized System of Instruction) Workshop which was attended by nine faculty from the Division of Natural Sciences (Lester Jones, Gail Jones, Linda Tillman, Harold Vincent, Steven Welsh, Jacqueline Hunter, Mary Ann Ryan, Douglas Ruby, and Croscina Crockett). The workshop was designed to provide an overview of PSI and why a faculty member might choose such an individualized system for instruction. The Workshop was conducted by three XU faculty who had had experience teaching PSI courses: Dr. Carmichael, Dr. Ann Olivier (Philosophy), and Dr. Frank Brotnerton (Psychology).
Spring, 1978	The CAUSE Committee conducted a Workshop on Science Teaching and the Development of Reasoning using materials by the same name by Karplus, et. al., Lawrence Hall of Science, U.C., Berkeley, for high school teachers and XU faculty. All CAUSE representatives had completed the same workshop and had received Continuing Education Credit for doing so at a special workshop sponsored by the NSTA at its spring meeting in Cincinnati in 1977. Since there were no materials for Mathematics, Lester Jones, Mathematics's CAUSE representative, developed special modules to supplement the materials available for the sciences.
April, 1978	The CAUSE Committee sponsored a workshop for the entire Division of Natural Sciences and the College of Pharmacy in order to provide the opportunity for faculty to scrutinize the first draft of materials developed under CAUSE. More than 30 faculty (about 70%) of those invited attended. At the workshop, faculty systematically considered and evaluated <u>every</u> objective for Biology 123, Biology 124, Chemistry 101, Chemistry 102, Mathematics 103, and Physics 201. The workshop was three hours in length on a Friday afternoon. A combination of dedication and promise of refreshments accounted for the high percentage of faculty who chose to attend.
Summer, 1978	The Workshop on Science Teaching and the Development of Reasoning was repeated for approximately 25 high school mathematics and science teachers from metropolitan New Orleans. There was no charge for participation.
Summer, 1978	The CAUSE Committee conducted the second special summer program for pre-freshmen. To a large extent, the program served as a place to field-test ideas which had been under discussion during the academic year without the constraints imposed by the need to cover given content or assign grades. The program, entitled Project SOAR (Stress On Analytical Reasoning), has gained national recognition in its own right as indicated by its inclusion in the <u>6th Report on Teaching</u> published by <u>Change</u> Magazine in August, 1978.

Summer, 1978	Dr. Carmichael attended a conference (by invitation) at the University of Nebraska-Lincoln for representatives from college-level, Piagetian-based programs. The programs represented are discussed in a publication entitled Multidisciplinary Piagetian-based Programs for College Freshmen published by one of the programs, ADAPT. The publication may be obtained by writing ADAPT, 213 Ferguson Hall, University of Nebraska--Lincoln, Lincoln, NE 68588.
Fall, 1978	Harold Vincent, Jacqueline Hunter, and JW Carmichael discussed Project SOAR via a presentation entitled "Can Piaget + Interdisciplinary Cooperation = Enhanced Problem-Solving?", at the NSTA meeting in New Orleans.
January, 1979	The CAUSE-funded, combined learning center for the sciences, the APLC, opened one-semester ahead of schedule at which Sr. Grace Mary Flickinger (Biology) assumed chairmanship of the committee. Dr. Carmichael had chaired the committee during the planning and development of the facility. The APLC was instantly popular, more than 50,000 persons used it during the first six months it was open. Appendix XVI contains a record of usage.
Spring, 1979	The CAUSE Committee sponsored a "How I do it workshop" for high school mathematics and science faculty from New Orleans. 37 high school teachers and 14 XU faculty attended.
Spring, 1979	Faculty from the Division of Natural Sciences attended a CAUSE-sponsored, "hands-on" introduction to the capabilities of the Tektronix and Apple Computers which had been purchased with CAUSE funds. This "workshop" consisted of ten hours of supervised experience spread over four weeks so as to allow all participants to actually use both computers. Those attending were: Jacqueline Hunter (Biology), Harold Vincent (Physics), Mary Ann Ryan (Chemistry), Sr. Eileen Benton (Mathematics), Bill Irlbeck (Mathematics), and Winston Brown (Mathematics). In addition, the entire Chemistry faculty (Sr. Mary Carl Malmstrom, John Sevenair, Warren Ray, Leonard Price, Donald Robinson, Mary Ann Ryan, Sr. Joanne Bauer, and Bernie O'Brien) participated in a similar activity as one part of their departmental CAUSE workshop later in the spring. Both activities were supervised by JW Carmichael. All faculty from either group who expressed an interest in further use of the terminals were given copies of the user's manuals. A number of the Mathematics faculty spent additional time experimenting with the use of the computers during the spring and summer.

Spring, 1979	The CAUSE Committee sponsored a workshop by Dr. Arthur Whimbey, author of Intelligence Can Be Taught (Innovative Sciences) and Problem-Solving and Comprehension: A Short Course in Analytical Reasoning (Franklin Institute Press), as a means of stimulating discussion of possible mechanisms for improving student performance on standardized exams. A brief overview of the workshop and a list of the 25 participants is given in Appendix II.
Spring, 1979	The CAUSE Committee submitted a document discussing Project SOAR for consideration for publication in The American Biology Teacher. It was published in March of 1980. (See Vol. 42, No. 3, pages 169-173.) See Appendix XVI.
May, 1979	The Workshop on Science Teaching and the Development of Reasoning was repeated for high school teachers from New Orleans and for faculty anticipating working in Project SOAR during the summer. The workshop was conducted by Donald Robinson, Lester Jones, and Jacqueline Hunter.
May, 1979	The workshop discussing mechanisms for improving scores on standardized exams, with emphasis on the use of "cognitive therapy"--the principal idea in Problem-Solving and Comprehension, was repeated by Dr. Whimbey for high school faculty from New Orleans and faculty anticipating working in Project SOAR.
Summer, 1979	The CAUSE Committee conducted the third version of Project SOAR, the special summer program for pre-freshmen entering Xavier with a major in the sciences. An overview of the program is given in Appendix III.
Summer, 1979	The CAUSE Committee submitted an article discussing the "cognitive therapy" portion of SOAR to The Journal of Reading. It was published in October of 1980. (See Vol. 24, No. 1, pages 5-10). A copy is in Appendix XVII.
Fall, 1979	The CAUSE Committee submitted an article describing the "bridge" nature of SOAR (between high school and college) to the Louisiana Journal of Science. The article has been accepted and should be published in 1980-81.
Fall, 1980	The CAUSE Committee compiled a list of audio-visual (science related) materials in the University Library and provided a copy to all science and mathematics faculty as a means of promoting usage of the APLC. The list was designed to be used in one's office and thus supplement the card catalog of such materials.
Fall, 1980	Two Division-wide workshops were conducted in early fall (9/14 and 9/21). The first provided the opportunity for all faculty to comment on the content of entry-level courses after two years of work. The second was a forum for sharing

ideas about providing the "sympathy" (mechanisms for assisting the educationally-disadvantaged) which makes it possible to maintain "standards" in the science departments. ("Standards with Sympathy" is often used to describe what Xavier, and particularly the sciences, attempt to provide in educational endeavors.)

Fall, 1979 — The CAUSE Faculty provided assistance to the Southern Regional Educational Board at a conference in New Orleans. Both Dr. Vincent and Ms. Hunter made presentations at the conference. A copy of the program is in Appendix XVII.

Fall, 1979 — Sr. Grace Mary Flickinger (Biology) expanded orientation workshops for Biology tutors to include tutors (and faculty) from the other three departments. The joint approach to training peer tutors was promoted by the availability of the APLC, the joint learning center. It was, as expected, very successful. (Please note that this endeavor, like the entire CAUSE project at XU, was a generalization of an idea which worked for one department to others as facilitated by cooperative efforts.)

Spring, 1980 — Dr. Vincent, Ms. Hunter, and Sr. Grace Mary made presentations about SOAR and XU's CAUSE Project at a Science Instruction Seminar sponsored by Southern Regional Education Board in Durham, NC.

Spring, 1980 — An overall evaluation of XU's CAUSE Project was conducted by Dr. Bobby Irby, Chairman of the Department of Science Education at the University of Southern Mississippi. See Appendix XVIII for his report.

Spring, 1980 — A Workshop on Science Teaching and the Development of Reasoning and one on the Cognitive Skills Approach to problem-solving was conducted for high school teachers from New Orleans and for faculty chosen to work in Project SOAR during the summer. Ms. Hunter, Mr. Jones, and Ms. Barbara Wells (McMain Magnet Secondary School, New Orleans) conducted the two.

Spring, 1980 — All four departments work cooperatively to develop plans for the continuation of CAUSE-developed activities after expiration of the grant. See Appendices XX-XXIII for details for each.

Spring, 1980 — An IDSE (NSF) proposal was prepared by the CAUSE Committee with Dr. Vincent providing leadership as a means of more widely disseminating information about techniques found successful at XU to local junior and senior high schools. It was funded in early fall.

Spring, 1980	Dr. Jones, Dr. Vincent, and Ms. Hunter discussed Project SOAR at a conference on Reasoning, Piaget, and Higher Education in Denver, Colorado.
Summer, 1980	The fourth version of Project SOAR was conducted by a combination of XU faculty and mathematics and science teachers from local high schools. Ms. Hunter (Biology), Dr. Jones (Mathematics), Ms. Barbara Wells (Chemistry--on leave from McMain Magnet Secondary School), and Dr. Carmichael worked in the program in 1980.
Fall, 1980	The CAUSE Committee becomes the "IDSE Advisory Committee" and even though the CAUSE Grant has expired and there is no monetary or release-time compensation continues to meet for one hour weekly to discuss and implement cooperative multi-departmental activities.
Fall, 1980	The IDSE Advisory Committee sponsored a workshop for Biology teachers from local Junior and Senior High Schools designed to promote use of innovative ideals to make science more accessible to the educationally-disadvantaged.
Fall, 1980	The IDSE Advisory Committee planned a workshop for high school chemistry teachers in conjunction with the Combined SE/SW Regional Meeting of the American Chemical Society in New Orleans. Eighty-eight area teachers attended.

SPECIAL EVENTS

In the fall of 1978, XU and the CAUSE Committee hosted a visit by Dr. James Rutherford, Director of the Science Education Directorate of the National Science Foundation.

In the spring of 1980, the University hosted a visit from Dr. Robert Menefee, Program Manager for NSF's CAUSE Program.

Activities Implemented by the Biology Department Via CAUSE:

Before receiving the CAUSE Grant Biology had had the opportunity to carry out some experimentation with different laboratory formats (including the Piagetian-based learning cycles developed by Ms. Hunter as a part of Project SOAR) and had established an outstanding peer tutorial service (courtesy of Sr. Grace Mary Flickinger). However, the CAUSE Grant provided funds, for the first time, to do in-depth analysis and revision of the entire sequence of entry-level courses. The effort over the past three years has been exceptionally fruitful. In the departmental-wide discussions at the beginning of the project, the faculty in the department decided to change entry-level Biology from a semester of General Biology and a semester of Zoology to a year of General Biology. Subsequent development of materials under CAUSE and their use in the new sequence resulted in an average increase of 20 percentile points on the CLEP General Biology Examination. Development of Biology materials was effected primarily by Sr. Grace Mary Flickinger (Departmental Chairperson) and Ms. Jacqueline Hunter (CAUSE Representative) with considerable assistance from the remainder of the faculty in the department--particularly Dr. Deidre Labat, Dr. Douglas Ruby, and Mr. Charles Ballard. A chronological sketch of Biology's activities during the grant period are as follows:

Summer, 1977	The CAUSE Grant was awarded.
Fall, 1977	The entire Biology Department met and, after extensive discussion over a period of weeks, finally decided to change from one semester each of General Biology and Zoology to one year of General Biology.
Fall, 1977	Sr. Grace Mary Flickinger, conducted a three-hour workshop for Biology peer tutors and organized the Department's tutorial service for the fall.
Fall, 1977	Ms. Hunter attended the CAUSE-sponsored workshop to familiarize faculty with individualized instructional systems with emphasis on PSI.
Fall, 1977	The five Piagetian-based learning cycles developed by Ms. Hunter during the previous year were modified and improved on the basis of experimentation with their use in the summer of 1977 in Project SOAR.
January, 1978	Sr. Grace Mary organized the Biology peer tutorial service for the spring semester, continuing to set an example for the other departments.
Spring, 1978	Content objectives for both semesters of Biology 123 (the first semester) were developed.
Spring, 1978	A draft of a "handbook" for Biology 123 and a laboratory manual for Biology 123L was developed. The handbook included content objectives, related sample problems, and alternate pathways for mastering the content.

Spring, 1978	Content objectives for both Biology 123 and 124 were evaluated by faculty from the Division of Natural Sciences and the College of Pharmacy at a CAUSE-sponsored workshop.
Spring, 1978	Ms. Hunter assisted the other members of the CAUSE Committee in conducting a Workshop on Science Teaching and the Development of Reasoning for mathematics and science faculty from local high school (and XU).
Spring, 1978	Dr. John Ruffin, Department of Biology at North Carolina Central University, served as an outside consultant to evaluate content of the entry-level Biology sequence. He was on campus for two days and submitted the formal report in Appendix IV.
Spring, 1978	The CLEP General Biology Examination was administered to a randomly-selected group of students in order to obtain base-line for measuring performance of pre-CAUSE courses.
Spring, 1978	A common final was administered in all sections of students completing General Biology.
Spring, 1978	Sr. Grace Mary Flickinger, Ms. Jacqueline Hunter, Dr. Douglas Ruby, and Mr. Charles Ballard met for two days to conclude refinement on the basis of consideration of comments of faculty from the other departments and the outside consultant.
May, 1978	Ms. Hunter assisted in conducting a Workshop on Science Teaching and the Development of Reasoning for local high school teachers of mathematics and science with emphasis on those who would be teaching in Project SOAR in 1978.
Summer, 1978	Materials for Biology 123 and 123L were refined, typed, and prepared for use in the fall.
Summer, 1978	Ms. Jacqueline Hunter conducted the Biology portion of the pre-freshman summer program for science students using the five Piagetian-based learning cycles she had previously developed. One purpose of the program was to experiment with such materials to determine the extent to which they might be appropriate in regular entry-level courses. She was assisted by Ms. Wanda Harris, Biology teacher from McDonogh #35 Senior High.
August, 1978	Sr. Grace Mary conducted a three-hour workshop for Biology tutors and organized the peer tutorial service for the fall.
Fall, 1978	Sr. Grace Mary Flickinger joined the CAUSE Committee.

Fall, 1978	Ms. Hunter was one of three persons (JW Carmichael and Harold Vincent were the other two) discussing Project SOAR at the NSTA meeting in New Orleans.
Fall, 1978	Biology 123 and 123L materials were field-tested in all four sections of General Biology. Faculty teaching the courses were: Sr. Grace Mary, Dr. Deidre Labat, Dr. Douglas Ruby, and Ms. Jacqueline Hunter.
Fall, 1978	Sr. Grace Mary, Ms. Hunter, Dr. Labat, and Dr. Ruby met biweekly for one hour to coordinate activities associated with teaching the entry-level courses and to plan further refinement. This activity continued in the spring.
Fall, 1978	Development of Biology 124 materials was completed by Sr. Grace Mary and Ms. Hunter with extensive input from other members of the Biology Department.
January, 1979	With the opening of the APLC, the Biology tutorial service moved to that facility and expanded its AV holdings with funds provided by CAUSE. The service continued to be excellent.
Spring, 1979	Biology 124 materials were field-tested in all three sections of General Biology. Faculty teaching the courses were: Ms. Hunter, Dr. Ruby, and Dr. Labat.
Spring, 1979	Ms. Hunter attended the CAUSE-sponsored workshop to acquaint faculty with the use of Tektronix and Apple computers with emphasis on possible application in computer-based instruction.
Spring, 1979	Ms. Hunter discussed XU's CAUSE Project at the NSTA meeting in Atlanta.
Spring, 1979	Dr. Labat, Ms. Hunter, and Sr. Grace Mary Flickinger (Chairperson) attended a three-hour, CAUSE-sponsored workshop by Dr. Arthur Whimbey to consider methods of teaching so as to promote the problem-solving skills needed to perform well on standardized examinations.
Spring, 1979	Ms. Hunter presented her knives-and-forks simulation of Meiosis and Mitosis at the "How I Do It Workshop" sponsored by the CAUSE Committee for mathematics and science teachers from local high schools.
Spring, 1979	Dr. John Ruffin, Department of Biology at North Carolina Central University, spent two days at Xavier evaluating CAUSE materials and discussing ways of further improving the entry-level Biology courses. His report appears in Appendix V.

Spring, 1979	The CLEP General Biology Examination was administered to a randomly-selected group of students completing Biology 124 on an option basis without advance warning and with only minimal reward for good performance--i.e., in a manner similar to that used at the equivalent time in 1978.
Spring, 1979	Common final examinations were given to students completing both Biology 123 and 124.
Spring, 1979	Sr. Grace Mary Flickinger, Ms. Hunter, Dr. Ruby, and Mr. Ballard met in a two-day workshop to complete the year-long process of evaluating and modifying materials which had been field-tested in General Biology in 1978-79.
May, 1979	Ms. Jacqueline Hunter co-directed (with Mr. Robinson and Mr. Jones) a Workshop on Science Teaching and the Development of Reasoning for mathematics and science teachers from local high schools and faculty who would be working Project SOAR in 1979.
Summer, 1979	Ms. Jacqueline Hunter conducted the Biology portion of the third version of Project SOAR, the special summer program for pre-freshmen science majors. The five Piagetian-based laboratory experiments she had developed and revised earlier were used as textual material. Ms. Wanda Harris, Biology teacher from McDonogh #35 Senior High, assisted her in this endeavor.
July, 1979	After a short orientation session, Sr. Grace Mary Flickinger (Chairperson) began using the Tektronix graphic terminals in the APLC for data reduction of the sort needed for the on-going evaluation of General Biology planned in the future.
Summer, 1979	Sr. Grace Mary Flickinger and Ms. Jacqueline Hunter received acceptance notices for papers they had submitted for presentation at the upcoming meeting of the National Association of Biology Teachers. The meeting will be held in New Orleans. Sr. Grace Mary's two presentations will consider her dermatoglyphic research and the Biology portion of XU's CAUSE Grant. Ms. Hunter's two will cover Project SOAR and her novel simulation of Meiosis and Mitosis.
Summer, 1979	CAUSE-developed materials for the General Biology sequence were refined, duplicated, and prepared for use by all students in the sequence in 1979-80.

October, 1979	Sr. Grace Mary Flickinger (Chairman, Biology) conducted a workshop for all peer tutors working in the APLC. This was the first time the four departments had conducted joint tutorial training sessions.
October, 1979	Sr. Grace Mary Flickinger discussed XU's CAUSE Project at the International Congress on Individualized Instruction in Athens, Georgia. A copy of the program is included in Appendix XIX.
October, 1979	Ms. Jacqueline Hunter presented a paper entitled "Mitosis and Meiosis with Knives, Forks and Spoons" at the National Association of Biology Teachers in New Orleans.
October, 1979	Ms. Jacqueline Hunter presented a paper entitled "Project SOAR: A Multidisciplinary Summer Program for Pre-Freshmen" at the National Association of Biology Teachers in New Orleans.
October, 1979	Sr. Grace Mary Flickinger presented a paper on the Biology portion of XU's CAUSE Grant at the National Association of Biology Teachers in New Orleans.
November, 1979	Ms. Jacqueline Hunter discussed Project SOAR (along with Dr. Vincent) at the Science Instruction Seminar sponsored by the Southern Regional Education Board in New Orleans. See Appendix XVII for a copy of the program.
November, 1979	Sr. Grace Mary Flickinger discussed the APLC (Alternate Pathways Learning Center) at XU at the Science Instruction Seminar sponsored by Southern Regional Education Board.
December, 1979	Common final exams were given in all four sections of Biology 123.
Spring, 1980	Biology 124 lab materials were field-tested.
April, 1980	Ms. Jacqueline Hunter discussed Project SOAR (along with D[illegible]nes and Dr. Vincent) at the National Conference on Reasoning, Piaget and Higher Education in Denver.
April, 1980	Ms. Hunter discussed Project SOAR at the Science Instruction Seminar sponsored by the Southern Regional Education Board in Durham, North Carolina.
April, 1980	Sr. Grace Mary Flickinger discussed the Alternate Pathways Learning Center at XU at the Science Instruction Seminar sponsored by the Southern Regional Education Board in Durham, North Carolina.

Spring, 1980	The Biology Department completes plans for continuation of CAUSE-developed activities after the grant expires. See Appendix XX for details.
May, 1980	The CLEP General Biology Examination was administered to a randomly-selected group of students completing Biology 124.
May, 1980	Common final examinations were given to students completing both Biology 123 and 124.
June, 1980	Ms. Jacqueline Hunter co-directed (with Dr. Jones) a Workshop on Science Teaching and the Development of Reasoning for mathematics and science teachers from local high schools and faculty who would be working in Project SOAR in 1980.
Summer, 1980	Ms. Jacqueline Hunter conducted the biology portion of the fourth version of Project SOAR.
Summer, 1980	Ms. Jacqueline Hunter, Dr. Deidre Labat, and Dr. Douglas Ruby modified the Biology 123 and 124 materials on the basis of input from faculty during the spring semester.
Summer, 1980	CAUSE-developed materials were duplicated and prepared for use by students in all Biology 123 and 124 sections in 1980-81.
Fall, 1980	Ms. Hunter continued to meet with the CAUSE Committee-turned-IDSE Advisory Committee for one hour weekly.
October, 1980	Ms. Hunter discussed "Mitosis and Meiosis with Knives, Forks and Spoons" at the IDSE-sponsored workshop for Biology teachers from local junior and senior high schools.

Activities Implemented by the Chemistry Department Via CAUSE:

Chemistry had opted for departmentally-determined content for general chemistry in 1972 and had spent numerous hours determining and refining its idea of what that content should be in the five years preceding the CAUSE Grant. Further, the department had developed the sort of "handbook" proposed for the other departments via CAUSE at that time and had had five years of actual use of the materials in an individualized, self-paced format (PSI modified to including the option of taking an extra semester to complete the course if needed and of repeating finals). This modification had resulted in significant improvement in the level of student performance in the course. The average score on the ACS Cooperative Examination in General Chemistry (a requirement for completion of the sequence at XU) increased more than 20 percentile points for the first attempt at the exam and was slightly above the national average when repeats (on different versions) were considered. In spite of expectations, however, the increased level of performance on shifting to an individualized format was not accompanied by a reduction in attrition from general chemistry. The percentage of persons completing both semesters of the sequence remained about the same as it had been in the traditional courses--slightly more than 50%. Since failure to complete general chemistry is a primary reason why many (if not most) students choose to change from science-related majors, for Chemistry the CAUSE Grant was primarily designed to provide the opportunity to further modify the delivery system so as to reduce attrition WITHOUT decreasing performance. Chemistry's CAUSE-related activities were implemented for the most part by Mary Ann Ryan and JW Carmichael with extensive assistance from Donald Robinson and (in 1978-79) Sr. Joanne Bauer. A chronological list of Chemistry's CAUSE activities during the first two years of the grant period are:

Spring, 1977	The Chemistry Department met and made suggestions for refinement of general chemistry in the usual yearly manner. At this time, the decision was made to adopt Chemistry: The Central Science by Brown and Lemay as the textbook in the course for the upcoming year. This was a major change in direction since changing textbooks necessitated changing both the 300+ pages of the handbook and the 128 quizzes used in the course.
Spring, 1977	All students completing Chemistry 102 took one or more versions of the ACS Cooperative Examination in General Chemistry as a requirement for completing the course.
Summer, 1977	The CAUSE Grant was awarded to the University.
Summer, 1977	Mary Ann Ryan and JW Carmichael modified approximately one-half of the first semester of Chemistry 101 and Chemistry 101L in line with decisions reached at the spring meeting of the Chemistry department.

Fall, 1977	All classes in Chemistry 101 and 101L began to use the newly modified materials while the remaining revision was completed--often only shortly before needed by the students. The lecture handbook consisted of modules with carefully specified objectives, correlated sample problems, and a variety of mechanisms for learning the content including audio tapes, tutoring, etc. The latter are the "alternate pathways" which provided the name for much of the activity associated with the CAUSE Grant at XU. The laboratory manual was composed of a series of Piagetian-based "learning cycles" developed on the basis of experimentation with a RULE/LOCI Grant in 1976-77. Modification/refinement of three-fourths of a year's course while field-testing is not a recommended way of remaining sane.
Fall, 1977	The prescription for the Chemistry 101 final was refined to fit the newly modified course.
Fall, 1977	Mary Ann Ryan attended the first portion of an NSF Chautauqua-type short course entitled "Patterns of Problem-Solving" at the University of Maryland--Baltimore.
Fall, 1977	Dr. Carmichael conducted a CAUSE-sponsored Workshop designed to acquaint XU faculty with PSI (Personalized System of Instruction). Dr. Ryan attended.
Spring, 1978	Chemistry 101 and 102L materials modified via CAUSE were field-tested while final modification and refinement was completed.
Spring, 1978	Dr. Ryan attended the second portion of the NSF Chautauqua-type short course, Patterns of Problem Solving, at the University of Maryland.
Spring, 1978	Dr. Ryan attended a Guided Design Workshop conducted by the University on campus.
Spring, 1978	Content objectives for both Chemistry 101 and 102 were evaluated by faculty from the Division of Natural Sciences and the College of Pharmacy at a CAUSE-sponsored workshop.
Spring, 1978	Dr. Carmichael and Dr. Ryan assisted the remainder of the CAUSE Committee in conducting the Workshop on Science Teaching and the Development of Reasoning for high school and XU faculty. Donald Robinson attended as a participant and earned one Continuing Education Unit from the University for doing so.
Spring, 1978	Dr. Theodore Brown, Chairman of the Department of Inorganic Chemistry at the University of Illinois and author of the text used in general chemistry at XU (Chemistry. The Central Science), served as an outside consultant to evaluate the content of the general chemistry sequence. He was on campus for two days and submitted the formal report in Appendix VI.

Spring, 1978	The question bank for Chemistry 101 was completed. It consists of ten questions for each of the seventy types of questions chosen for the prescription for the Chemistry 101 final.
Spring, 1978	The ACS Cooperative Examination in General Chemistry was administered to all students completing Chemistry 102. The CLEP (College-Level Examination Program by ETS) General Chemistry exam was also administered to one laboratory section. The students were not told in advance that they would be required to take the examination. Instead it was sprung on the students unexpectedly as they walked into laboratory and described as a method of obtaining a few (unspecified) "extra points".
Spring, 1978	The entire Chemistry faculty (Sr. Mary Carl Malmstrom, Joyce Corrington, JW Carmichael, Monty Herr, Leonard Price, Warren Ray, Mary Ann Ryan, Donald Robinson, and John Sevenair) attended a two-day workshop to conclude the in-depth consideration and refinement of materials for Chemistry 101 and 102 on the basis of comments made by faculty in other departments at the Division-wide workshop CAUSE had sponsored earlier in the spring.
May, 1978	Donald Robinson and JW Carmichael assisted the other members of the CAUSE Committee in conducting (once again) the Workshop on Science Teaching and the Development of Reasoning for high school teachers and faculty who would be working in Project SOAR in 1978.
Summer, 1978	Materials for Chemistry 101, 102, 101L, and 102L were refined, typed, and duplicated for use in the fall.
Summer, 1978	Donald Robinson conducted the Chemistry portion of the pre-freshmen summer program (Project SOAR) for science majors using the five Piagetian-based learning cycles previously developed by Mary Ann Ryan and JW Carmichael. He was assisted in this effort by Ms. Georgilyn Andry, Chemistry teacher at McDonogh #35 Senior High in New Orleans. Dr. Carmichael directed the same program.
Fall, 1978	CAUSE-refined materials for Chemistry 101 and 101L are used for the second time. In addition, increased emphasis was placed on the introduction of new elements to encourage students to remain in the course.
Fall, 1978	JW Carmichael was one of three CAUSE Committee members (Harold Vincent and Jacqueline Hunter were the other two) to discuss Project SOAR at the NSTA meeting in New Orleans via a paper entitled "Can Piaget + Interdisciplinary Cooperation = Enhanced Problem-Solving?"

Fall, 1978	Dr. Carmichael attended the Networks National Conference in San Francisco as one of three panelists invited to discuss "Sympathy versus Standards in the Sciences: Overcoming Student Deficiencies". Dr. Ryan also attended the conference using University funds.
January, 1979	With the opening of the APLC, Chemistry moved its AV materials, reference texts, tutorial service, etc. into that area and began using it for the numerous activities sponsored as a part of the effort to improve retention in General Chemistry. The latter included systematically teaching notetaking skills to those who needed it (all were required to turn in notes to determine who these were), teaching all students what a definition is and how to write a good one, increasing emphasis on learning general problem-solving skills, etc.
Spring, 1979	Sr. Joanne Bauer joined the Chemistry faculty with primary responsibility in the problem-solving drills associated with General Chemistry and began to work with Mary Ann Ryan, Donald Robinson, and JW Carmichael as CAUSE-related activities were implemented.
Spring, 1979	Dr. Ryan attended an NSF-sponsored conference for institutions which had had MISIP Grants as an invited speaker to discuss the success in increasing performance in General Chemistry at Xavier as discussed in the beginning of this section. The conference was held in Washington.
Spring, 1979	CAUSE-refined Chemistry 102 and 102L materials were used for the second time with added emphasis on features to promote retention in the course.
Spring, 1979	Dr. Carmichael conducted the CAUSE-sponsored workshop to investigate the usage of the Tektronix and Apple computer terminals purchased with CAUSE funds and located in the APLC. Dr. Ryan attended the workshop.
Spring, 1979	Dr. Sevenair, Sr. Mary Carl Malmstrom (Chairperson), and Dr. Ryan attended the CAUSE-sponsored workshop on problem-solving and increasing scores on standardized exams which was conducted by Dr. Whimbey. See Appendix II for a description.
Spring, 1979	Dr. Arthur Whimbey, Visiting Professor in Mathematics at Xavier and author of Intelligence Can Be Taught (Innovative Sciences) and Problem-Solving and Comprehension: A Short Course in Analytical Reasoning, served as a consultant for two days. His primary purpose was to evaluate the delivery mechanism used in the General Chemistry sequence and to suggest ways of reducing attrition from the courses. His report is included in Appendix VII.

Spring, 1979	The CLEP General Chemistry examination was administered to a portion of the General Chemistry class in a manner such that it could be counted as a final examination if desired. It should be noted that this was considerably different than in 1978 when it was administered unexpectedly to one laboratory section. The decision to administer it in this fashion arose from the desire to attempt to determine the degree of correlation between the CLEP and ACS General Chemistry examinations. The latter was desirable because Xavier has recently decided to accept CLEP credits but has no real feel for what the various scores mean with respect to the courses taught on campus.
Spring, 1979	The ACS Cooperative Examination in General Chemistry was administerd to a large majority of students completing Chemistry 102 (the remainder took the CLEP mentioned above). Since the ACS examinations have been given in a similar manner for a number of years, it is possible to compare performance before and after the grant period.
Spring, 1979	All Chemistry faculty (Sr. Mary Carl Malmstrom, Dr. Ryan, Dr. Carmichael, Dr. Price, Dr. Sevenair, Reverend Ray, Mr. Donald Robinson, and Sr. Joanne Bauer) met for two days in a workshop designed to acquaint the participants with the capabilities of the Tektronix and Apple computers located in the APLC. This activity was a culmination of CAUSE-sponsored consideration of refinement of General Chemistry for the year.
Spring, 1979	Donald Robinson co-directed (with Lester Jones and Jacqueline Hunter) a Workshop on Science Teaching and the Development of Reasoning) for high school and XU faculty with emphasis on those planning to teach in Project SOAR in 1979.
Summer, 1979	Donald Robinson conducted, with assistance from Ms. Georgilyn Andry who teachs Chemistry at McDonogh #35 Senior High, the Chemistry portion of Project SOAR, the special summer program for pre-freshmen interested in the sciences. It should be noted that this is the third such summer the program has been offered and that an overview of it is contained in Appendix III.
Summer, 1979	Further modification and refinement of the General Chemistry materials was completed and materials were duplicated for distribution (at a cost) to students in the fall. A detailed description of the General Chemistry sequence at present has been compiled into a document which has been submitted for publication.

Fall, 1979	An article describing XU's CAUSE-developed General Chemistry course was submitted to the Journal of Developmental and Remedial Education. It was accepted and published in the Winter, 1979 issue. See Appendix XXIV.
Fall, 1979	An article describing XU's Piagetian-based (and CAUSE-developed) General Chemistry Laboratory program was submitted for publication to the Journal of Chemical Education. It was published in September, 1980 (Vol. 57, No. 9, pages 642-645. See Appendix XXV for a photocopy.
December, 1979	Dr. Carmichael was an invited speaker at a Networks Conference held in Washington, DC. He discussed SOAR and the CAUSE-related activities at XU.
December, 1979	The American Chemical Society Cooperative General Chemistry Examination was administered to all students completing Chemistry 102. All students completing Chemistry 101 were administered variations of the final developed from the prescription arrived at via SOAR.
December, 1979	Plans for continuing CAUSE-related activities in General Chemistry were completed. Appendix XXI contains a copy.
Spring, 1980	The American Chemical Society standard exams and prescription finals were administered for all students completing Chemistry 102 and 101, respectively.
Summer, 1980	Ms. Barbara Wells, high school chemistry teacher from McMain Magnet Secondary School, and Ms. Georgilyn Andry, high school chemistry teacher from McDonogh #35 High School, conducted the Chemistry portion of SOAR.
Summer, 1980	CAUSE-developed materials were refined, duplicated and prepared for use in the fall.
Summer, 1980	Dr. Carmichael, Ms. Barbara Wells (a high school teacher from McMain Magnet Secondary School on leave at XU teaching chemistry in 1979-80), and Sr. Joanne Bauer made presentations at the 6th Biennial Conference on Chemical Education in Rochester, NY See Appendix XXVIII for details.
Fall, 1980	JW Carmichael became a member of the IDSE Advisory Committee (along with the other members of the former CAUSE Committee) and continued to meet weekly with counterparts from Biology, Mathematics, and Physics.
Fall, 1980	Sr. Joanne Bauer conducted a special 2-day workshop for the two new faculty who would be working in the General Chemistry program in 1980-81. (Sr. Joanne has taken temporary leave to complete graduate work at the University of New Orleans.)

Fall, 1980	JW Carmichael organized, as one part of his duties on the IDSE Advisory Committee, a workshop for high school teachers in conjunction with the Combined SE/SW Regional Meeting of the American Chemical Society here in New Orleans.

Activities Implemented by the Mathematics Department Via CAUSE:

The CAUSE Grant at Xavier provided funds to improve Mathematics 103 (Precalculus) and Mathematics 104 (Calculus I), the two college-level courses required of most science majors. This sequence was developed as a means of providing exposure to calculus to the health science students. The latter is desirable since many of them latter consider graduate programs which require calculus for admittance. (Most institutions do not require that health science students take calculus. Instead, they take statistics and algebra or trigonometry. Xavier has chosen to require Precalculus/Calculus I for most science students as one part of its effort to encourage its graduates, Black Americans, to aspire to high career goals and to prepare them for doing so.) Precalculus is a three credit-hour course which contains components of both algebra and trigonometry. Calculus I is both the terminal course for most students and, because XU is small, the first semester of a three-semester calculus sequence for others. A student may enter the sequence only upon either a) passing the University's Mathematics Placement Examination or b) successfully completing a non-degree credit course, Mathematics 100. Because of the obvious complexity of attempting to develop two courses which may be entry-level for some students while intermediary for others and terminal for some while merely the first of a sequence for others, implementation of the Mathematics portion of the CAUSE Grant has been extremely time-consuming. During the grant period, the Mathematics Departments has met weekly for a minimum of one hour to discuss not only Mathematics 103 & 104 but also the developmental course which precedes it and the Calculus courses which follow. This concentrated effort to considered the entire set of courses in concert, has resulted in the development of a skills-oriented Precalculus course and an intuitive one-semester survey of Calculus, both of which emphasize practical applications. While both of these courses appear to be in line with what innovative educators are advocating, at present they differ significantly from what is actually offered at most other institutions. The Mathematics Department therefore appears to have provided another instance in which Xavier's unique challenges has produced a unique solution. A list of the activities of the CAUSE-related activities of the Mathematics Department follows:

Summer, 1977	The CAUSE Grant was awarded.
Fall, 1977	The Mathematics Department began holding weekly one-hour meetings for the purpose of discussing the content, delivery mechanism, and the relationship of Mathematics 103 and 104 to other Mathematics courses. The meetings have continued throughout the entire two-year period and, on occassion, have been supplemented by more extended brain-storming sessions. All faculty in the Department have attended the meetings regularly.
Fall, 1977	Mr. Clarence Inniss organized and conducted the Mathematics Peer Tutorial Service for the semester.
Fall, 1977	Mr. Lester Jones, Ms. Gail Jones (part-time faculty), and Ms. Linda Tillman (part-time faculty) attended the CAUSE-sponsored PSI Workshop on XU's campus.

Fall, 1977	The five Piagetian-based learning cycles developed by Mr. Jones and used in the previous summer's special summer program, Project SOAR, were revised. Although Mathematics has no formal laboratory courses, the experimentation in SOAR has provided a number of ideas for improvement of lecture courses as the Department has moved toward a practical approach to entry-level science majors Mathematics courses.
December, 1977	The specification of content objectives for Mathematics 103 (Precalculus) was completed.
Spring, 1978	Mr. Inniss continued to organize and direct the Department's peer tutorial service for the spring semester.
Spring, 1978	The first draft of the Precalculus Handbook was developed.
Spring, 1978	Content objectives for Precalculus were evaluated (individually) by members of the Division of Natural Sciences and the College of Pharmacy at a joint CAUSE-sponsored, three-hour workshop.
Spring, 1978	Dr. Solomon Garfunkel, Associate Director, UMAP, and member of the Mathematics Department, the University of Connecticutt, Storrs, spent two days at XU as a consultant evaluating the course content of Pre-Calculus and discussing mechanisms for improving performance in the course. His report is included in Appendix VIII.
Spring, 1978	Seven of the eight Mathematics faculty (Mr. Jones, Sr. Rosemarie Kleinhaus, Dr. Fontova, Dr. Irlbeck, Mr. Innis, Mr. Brown, and Ms. Nelson) attended a two-day workshop to conclude the refinement of Mathematics 103 materials with special consideration given to comments from other faculty during the Division-wide evaluation workshop.
Spring, 1978	Mr. Jones assisted the remainder of the CAUSE Committee as they conducted a Workshop on Science Teaching and the Development of Reasoning for high school and XU faculty. He developed materials specifically for Mathematics to be used in this effort to supplement those available for science from Karplus, et. al., Lawrence Hall of Science, U. of California, Berkeley.
Spring, 1978	The CLEP Precalculus Examination was administered to all students completing Precalculus in the spring. It was not given as a final, but rather as an option activity for which the students received some small number of extra credit points.
Spring, 1978	The Mathematics Departments prepared and administered a common final in all sections of Precalculus for the first time.

May, 1978	Mr. Jones assisted other XU science faculty to conduct a Workshop on Science Teaching and the Development of Reasoning for high school and XU faculty with emphasis on those who would be teaching in Project SOAR in 1978.
May, 1978	Modifications were made to the materials in the Precalculus Handbook previously developed on the basis of refinement effected by the Mathematics faculty in the two-day workshop conducted earlier and the materials were duplicated for use in the summer.
Summer, 1978	Sr. Rosemarie Kleinhaus and Dr. Bill Irlbeck field-tested the Mathematics 103 materials for the first time.
Summer, 1978	Mr. Jones conducted the Mathematics portion of Project SOAR, the special summer program for science students, using the five Piagetian-based learning cycles he had previously developed and refined. He was assisted in this effort by Mr. Calvin Cognevich from McMain Magnet Senior High. This effort, as noted previously, provided an opportunity to try out ideas under consideration for inclusion in entry-level courses with the constraints of teaching content and giving grades.
Summer, 1978	Mr. Jones began development of audio-tapes to be used by students in Precalculus, Mathematics 103. This was one of the "alternate pathways" chosen by the Mathematics Department in the weekly meetings conducted in 1977-78.
Summer, 1978	The Precalculus materials were further modified and refined on the basis of the pilot use by Sr. Rosemarie and Bill Irlbeck in summer school. The new materials were then duplicated and assembled for distribution to all Precalculus students the falling fall.
Fall, 1978	Dr. Bill Irlbeck joined the CAUSE committee as a regular member.
Fall, 1978	Mathematics 103 materials were used by all faculty teaching Precalculus. The group consisted of Mr. Jones, Mr. Brown, Dr. Fontova, Dr. Irlbeck, and Sr. Rosemarie Kleinhaus (Chairperson).
Fall, 1978	Mr. Winston Brown assumed responsibility for the Mathematics Peer Tutorial program for the year.
Fall, 1978	Mr. Jones completed the audio tape "alternate pathway" in time for use as needed during the semester.

Fall, 1978	The Mathematics Department continued to meet weekly for a minimum of one hour as the Department considered development of Mathematics 104 and extensive revision of the developmental mathematics courses. During this semester, the Department reached the decision to use an intuitive approach to the first semester of Calculus (Mathematics 104) and to make the course a survey.
Fall, 1978	The prescription for the common finals to be administered in Precalculus was completed.
Fall, 1978	A common final examination was administered to all Mathematics 103 sections. The five faculty teaching sections, and participating in the administration of the common exam, were: Winston Brown, Esther Fontova, Bill Irlbeck, Lester Jones, and Sr. Rosemarie Kleinhaus.
January, 1979	With the opening of the APLC, the Mathematics Tutorial Service moved to that facility along with the Department's expanded AV holdings which had been purchased with CAUSE funds. Mr. Brown continued to direct the tutorial program. More than 50,000 individuals used the APLC during the first six months it was open.
January, 1979	Dr. Arthur Whimbey, author of Intelligence Can Be Taught (Innovative Sciences) and Problem-Solving and Comprehension: A Short Course in Analytical Reasoning (Franklin Institute Press), joined the Mathematics Department as a Visiting Professor on a short-term basis. Dr. Whimbey was specifically hired to work in the developmental Mathematics program as one part of the effort to improve it and thus provide a better foundation for Mathematics 103.
Spring, 1979	Content objectives were specified for Calculus I (Mathematics 104) and a "handbook" for the course was developed.
Spring, 1979	Dr. Irlbeck, Mr. Brown, Dr. Fontova, and Sr. Eileen Benton attended the CAUSE-sponsored workshop to acquaint faculty with the capabilities of the Tektronix and Apple computer terminals which had been purchased with CAUSE funds. All attended as a result of an interest in experimenting with computer-based instruction in Mathematics and all spent considerably more time with the computer than the ten hours officially sponsored by the CAUSE Committee.
Spring, 1979	Mr. Jones, Sr. Rosemarie (Chairman), Dr. Fontova, Sr. Eileen Benton, and Dr. Bill Irlbeck attended the 3-hour, CAUSE-sponsored workshop by Dr. Whimbey to consider ways of teaching so as to promote the development of the problem-solving skills needed to perform well on standardized exams.

Spring, 1979	Dr. Raymond Coughlin, author of Applied Calculus and member of the Mathematics Department at Temple University, visited XU for two days as a consultant to evaluate the Precalculus/Calculus I materials and to make suggestions for improvement. His final report is included in Appendix IX.
Spring, 1979	The CLEP Precalculus examination was given to all students completing Mathematics 103 in the spring.
Spring, 1979	A common final examination was given in Mathematics 103 (Precalculus) for the third consecutive semester.
Spring, 1979	Sr. Rosemarie Kleinhaus, Mr. Jones, Sr. Eileen Benton, Dr. Irlbeck, Dr. Fontova, and Mr. Brown attended a two-day workshop to complete the refinement of Calculus I materials on the basis of comments by the consultant, Dr. Coughlin.
May, 1979	Dr. Bill Irlbeck and Dr. Arthur Whimbey attended a conference discussing the current status of Mathematics Education. The meeting was held at Jackson State University in Jackson, Mississippi.
May, 1979	Mr. Jones co-directed (with Ms. Hunter and Mr. Robinson) a Workshop on Science Teaching and the Development of Reasoning for high school teachers and faculty who anticipated working in Project SOAR in 1979.
Summer, 1979	Mr. Lester Jones and Sr. Kathleen Bahlinger (Mathematics teacher from St. Joseph's Academy) conducted the Mathematics portion of the third version of Project SOAR, the special summer program for pre-freshmen science majors. The five Piagetian-based learning cycles which Mr. Jones had developed earlier were used in the program.
Summer, 1979	Sr. Rosemarie Kleinhaus and Dr. Bill Irlbeck piloted Mathematics 104 materials with Dr. Irlbeck completing the last phases of development in time for usage in classes.
Summer, 1979	Two papers were accepted for presentation at the American Mathematics Association of Two-Year Colleges' national meeting in San Diego in the fall. One is a panel discussion by Sr. Rosemarie, Dr. Irlbeck, Mr. Jones, and Mr. Brown concerning Xavier's Mathematics-CAUSE materials and their use at XU; the other considers the Mathematics portion of Project SOAR and its implications for teaching Mathematics.
Summer, 1979	A common final was given in Mathematics 104 using the prescription which had been developed as the Calculus I objectives and handbook were completed.

Summer, 1979	Both Mathematics 103 and Mathematics 104 materials were refined, duplicated, and assembled for use in all sections of both courses in academic 1979-80.
October, 1979	Mr. Lester Jones presented a paper about Project SOAR at the American Mathematics Association of Two-Year Colleges' national meeting in San Diego. Dr. Irlbeck, Mr. Brown, and Mr. Jones presented a panel discussion at the same meeting on the Mathematics portion of the CAUSE project at Xavier and its impact on the entire freshman-level mathematics program.
Fall, 1979	Dr. Bill Irlbeck and Mr. Lester Jones used the Mathematics 1040 materials in all three sections of Calculus I and made final revisions. Common module exams were given throughout the course as well as a common final.
Fall, 1979	The common final was again administered in Mathematics 1030.
January, 1980	The mathematics faculty participated in the Math/Science Olympiad.
February, 1980	Several members of the Mathematics faculty participated in Dr. Irby's evaluation of the CAUSE Project at Xavier.
May, 1980	Mr. Jones and Dr. Vincent from the Physics Department served as consultants at Tougaloo College with regard to their attempts to implement a developmental mathematics program at Tougaloo.
Spring, 1980	Common module exams and common finals were given in all five sections of Mathematics 1030 and also in all five sections of Math 1040.
May, 1980	The CLEP exam in College Algebra-Trigonometry was administered to all students enrolled in Mathematics 1030.
May, 1980	The CLEP exam in Calculus was administered to all students enrolled in Mathematics 1040.
May, 1980	Dr. Irlbeck organized the files of exam questions for Mathematics 1030 and 1040. He also collected data on grade distributions for the past three years in all freshman level mathematics courses.
Spring, 1980	Plans for continuation of the CAUSE-developed activities in Mathematics were finalized. A copy is included in Appendix XXII.

Summer, 1980	Mr. Jones completed his dissertation!!
Summer, 1980	Dr. Jones, Ms. Joyce Harvey, Mr. Alfred Randazza, and Mr. Gibson Chighizola conducted the Mathematics and Computer Science portions of Project SOAR.
Summer, 1980	The CAUSE-developed mathematics materials were refined and prepared for use in the fall by Dr. Bill Irlbeck.
Fall, 1980	Dr. Lester Jones, Mathematics' representative on the CAUSE Committee, began serving on the IDSE Advisory Committee and the weekly one-hour meetings with Biology, Chemistry, and Physics continued as in the past.
Fall, 1980	Dr. Anthony DuRapau discussed XU's CAUSE-developed Mathematics Program at the 4th International Congress On Mathematical Education in San Francisco. See Appendix XXIX for an overview of his presentation.

Activities Implemented by the Physics Department Via CAUSE:

At Xavier most science students take Physics during their sophomore or junior year after having completed at least one, and probably all three, of the other entry-level courses being revised under CAUSE. Therefore, the entry-level courses in the other departments serve, to a large degree, as "filters" for Physics. As a result, the enrollment in Physics is lower than that in the other three courses and students who enter Physics are generally better prepared than are those entering the entry-level courses in the other departments. In spite of the "weeding-out" which has occurred in Biology, Chemistry, and Mathematics beginning courses, many students entering Physics still lack sufficient problem-solving skills to do well in the course. Therefore, Physics, like the other departments, is actively seeking ways of improving retention and level of performance in the entry-level Physics sequence taken by most science majors, Physics 201 and 202. In spite of laboring under two disadvantages not shared by the other three departments (little opportunity to develop courses in the past and a greater share per person of the burden of administering a department as a result of fewer faculty among whom to spread the work), the Physics Department made as much (and maybe more) progress as the other departments. Under the CAUSE Grant, Physics acquired its first comprehensive set of AV materials, had its first chance to investigate the use of computer-based instructional aids, established its first tutorial service (it had no space to do so formerly), and developed materials for students for both semesters of lecture and laboratory. Further, the materials have been piloted once, have been refined, and will be used for the third time in the fall of 1980. It should be noted this development is extremely important since it provided a base for the additional development which will be needed as Physics 201-202 changed from two four-credit hour courses to two three-credit hour ones in 1979-80. The activities effected by Physics in reaching the present state of development are listed below:

Summer, 1977	The CAUSE Grant was awarded.
Fall, 1977	The members of the Physics Department met and began specification of content objectives.
Fall, 1977	Dr. Harold Vincent attended the CAUSE-sponsored workshop to acquaint faculty with the advantages (and disadvantages) of an individualized delivery system such as PSI.
Fall, 1977	The five Piagetian-based learning cycles developed by Dr. Vincent in the previous year were modified and improved on the basis of experimentation with their use in the summer of 1977 in Project SOAR, the special summer program for pre-freshmen majoring in the sciences.
Fall, 1977	A comprehensive final examination was given to all students completing Physics 201.
Spring, 1978	Content objectives for Physics 201 were completed.
Spring, 1978	Content objectives for Physics 201 were evaluated by faculty from the Division of Natural Sciences and the College of Pharmacy at a CAUSE-sponsored workshop.

Spring, 1978	Course materials for both Physics 201 and 201L were developed. Those for the former included listings of content objectives, related sample problems, and sample exams. The laboratory materials included some Piagetian-based experiments developed as a result of the experience of using similar activities in the Physics portion of Project SOAR.
Spring, 1978	Dr. Vincent assisted the remainder of the CAUSE Committee in conducting a Workshop on Science Teaching and the Development of Reasoning for high school and XU faculty.
Spring, 1978	Dr. Charles Picketts, Chairman of the Department of Chemistry and Physics at Mississippi Valley State University, served as an outside consultant to evaluate the content of Physics 201 and discuss what should be in Physics. He spent two days on campus in this endeavor and submitted the formal report in Appendix X.
Spring, 1978	An examination comparable to that administered in 1977 was given as the final in Physics 202.
Spring, 1978	All members of the Physics Department (Harold Vincent, Juliette Ioup, Agustin Guitart, and Douglas Verrette) met as a group in a two-day workshop for the conclusion of in-depth consideration of the comments of faculty from other departments concerning Physics 201 materials and additional refinement.
May, 1978	Dr. Vincent assisted Mr. Jones, Ms. Hunter, and Dr. Carmichael in conducting a Workshop on Science Teaching and the Development of Reasoning for high school science and mathematics teachers with emphasis on those who would be teaching in Project SOAR in 1978.
May, 1978	Final revisions were made on Physics 201 and 201L materials and they were prepared for use in summer school.
Summer, 1978	Dr. Vincent taught the General Physics sequence using the materials which he had developed the previous year.
Summer, 1978	Dr. Vincent provided supervision to Ms. Helen Kerley (Carver Senior High) and Dr. Robert Perry (a self-employed physicist) as they conducted the Physics portion of Project SOAR. The five Piagetian-based learning cycles Dr. Vincent had developed previously were used in the program. Considerable emphasis was placed on additional experimentation so as to determine future use in regular entry-level courses.

Fall, 1978	Dr. Vincent was one of three persons (with Carmichael and Hunter) who presented a paper discussing Project SOAR at the NSTA meeting in New Orleans.
Fall, 1978	Physics 201 and 201L materials were revised on the basis of feed-back from the field-test conducted during the summer of 1978.
Fall, 1978	Some parts of the Physics 201 and 201L materials were used in the first half of General Physics as a means of field-testing the newly revised materials.
Spring, 1979	With the opening of the APLC, Physics established a tutorial service for the first time and moved into its space in the facility. CAUSE provided funds to purchase a wide variety of AV materials for use there.
Spring, 1979	Dr. Vincent attended the workshop to familiarize faculty with the Tektronix and Apple computer terminals which was sponsored by the CAUSE Committee.
Spring, 1979	Dr. Vincent attended the three-hour, CAUSE-sponsored workshop by Dr. Arthur Whimbey which was devoted to a consideration of methods of teaching to develop problem-solving skills with emphasis on those needed to perform well on standardized exams.
Spring, 1979	Dr. Vincent directed the "How I Do It Workshop" for science and mathematics faculty from local high schools (and XU).
Spring, 1979	Dr. Jack Lochhead, Director of the Cognitive Development Project and member of the Department of Physics at the University of Massachusetts--Amherst, served as a consultant for two days. He spent considerable time both discussing the content of Physics 201-202 and ways of improving performance in them (see Appendix XI for report).
Spring, 1979	Materials for Physics 202 and 202L were developed by Dr. Vincent with repeated input from other members of the Physics Department.
Spring, 1979	Final examinations similar to those used in previous years were administered to students completing the Physics sequence.
Spring, 1979	Dr. Vincent, Dr. Verrette, and Dr. Guitart met in a two-day workshop to complete the year-long process of evaluating and modifying materials for the General Physics sequence.
Spring, 1979	At the request of a number of departments, Physics agreed to reduce the credit hours for Physics 201 and 202 from four credit hours each to three credit hours each.

Summer, 1979	Dr. Vincent supervised Ms. Helen Kerley (Carver Senior High) and Mr. Oliver Vital (O. Perry Walker Senior High) as they conducted the Physics portion of Project SOAR, the summer program for pre-freshmen interested in the sciences.
Summer, 1979	Dr. Vincent taught Physics 201, 201L, 202, 202L using materials which had been developed the past two years with CAUSE funds.
Summer, 1979	Further refinement of materials were effected on the basis of the field-test during summer school and materials were prepared for use by all students in both Physics 201 and 202 in 1979-80.
Fall, 1979	Dr. Vincent discussed Project SOAR (along with Ms. Hunter) at the Science Instruction Seminar sponsored by the Southern Regional Education Board in New Orleans. See Appendix XVII for a copy of the program.
Fall, 1979	Plans for the continining to use CAUSE-developed Physics materials were completed. Details are in Appendix XXIII.
April, 1980	Dr. Vincent discussed Project SOAR at the Science Instruction Seminar sponsored by the Southern Regional Education Board in Durham, North Carolina.
Spring, 1980	Dr. Vincent discussed Project SOAR (along with Ms. Hunter and Mr. Jones) at the National Conference on Reasoning, Piaget and Higher Education in Denver, Colorado.
Spring, 1980	Dr. Vincent wrote a proposal for the dissemination of information about XU's activities re making science more accessible to the educationally-disadvantaged to local junior and senior high teachers. The project was submitted to the NSF under IDSE. It was funded in the fall of 1980.
Summer, 1980	Dr. Vincent refined and duplicated materials in preparation for use in the summer and fall of 1980.
Summer, 1980	Dr. Vincent taught Physics 201 and 202 using CAUSE-developed materials.
Fall, 1980	Oriented Dr. Akundi Murty, new Physics faculty member, in the use of CAUSE-developed materials.
Fall, 1980	Dr. Vincent directed the IDSE Grant with CAUSE Committee members assuming a supportative role as an IDSE Advisory Committee. Dr. Vincent initiated a newsletter for local junior and senior high science teachers which monthly disseminates information as well as organized (or helped do so) workshops for local Biology and Chemistry teachers.

IV. Evaluation

From its inception, formative evaluation during the development and field-testing of materials, summative evaluation at the end of the grant period, and on-going evaluation after the grant expires were integral components of XU's CAUSE Project. Although closely related in many areas, the three are discussed separately in this document for sake of clarity.

Formative Evaluation:

Formative evaluation of the CAUSE Project at Xavier was a constant process coordinated by the regular weekly meetings of the CAUSE Committee. It consisted of three, sometimes overlapping, phases: evaluation by other faculty within a given department, evaluation by faculty from other science departments at Xavier, and evaluation by at least one outside consultant per department per year. Each is described briefly below:

1. Formative Evaluation within a given department: Since XU is a small institution offering a limited number of upper-level courses, it is likely that most faculty in a given department will teach some part of the entry-level sequence during an academic year. Therefore, long-term acceptance of a "departmental" course necessarily requires that the entire department, not just the CAUSE representatives, be involved in the curriculum development undertaken. For this reason, great effort was expended in systematically seeking input from all members of each department as the project progressed. The effort to develop a truly departmental course was very successful. The materials developed are now used, willingly, by all faculty in each department when teaching the pertinent courses. The basic procedure by which this was accomplished follows.

Before beginning development--All four departments had had considerable opportunity to discuss plans for development before the proposal was submitted and during the time-lag while waiting to hear NSF's reaction to it. Upon receiving notification of the grant award, each department scheduled further meetings for all faculty to re-examine past decisions. In both Biology and Mathematics these meetings extended over a considerable period of time and, ultimately, resulted in drastic changes in both the content and approach taken in entry-level courses in the two departments.

During development--During development there was constant consideration of specific items at departmental meetings, especially in Biology and Mathematics where a relatively large group of faculty (approximately eight in each) were making their first attempt to reach a concensus as to what to exclude from the new departmental courses. (They had long since recognized that it would be impossible to teach everything that all of them had originally thought should be in the entry-level courses.)

After development, evaluation by other faculty at XU, and evaluation by outside consultants--After development, materials were evaluated by faculty from other departments and by outside consultants. Subsequently, an average of 75% of the faculty of the four departments met (by department) each year for two days immediately following spring finals to further refine the materials.

Continuing formative evaluation within a department--All four departments now conduct regular meetings each semester for those faculty teaching in the entry-level courses for the purpose of coordinating activities and considering further joint improvements. Completion of the specifications for the common finals during the last year of the grant will contribute significantly to the department's ability to perform year by year comparisons.

Revision of materials on a continuing basis after each step--After each step of the formative evaluation, time was taken to make modification and/or refinements suggested. As a result, the materials now in use truly represent a "departmental" effort rather than merely the view of one or two faculty who did the actual work. This effort, while very time consuming, was well worthwhile since the materials now developed are used willingly by all faculty within the four departments with no reservations.

2. Formative Evaluation by Other XU Mathematics and Science Faculty: Most science majors at Xavier must take a number of courses in science departments other than that in which they are majoring. Therefore, it is very important that members from other departments also have input in curriculum development in service courses, especially at the entry-level. The regular weekly meetings of the CAUSE Committee served as a major source of formative evaluation from other departments on a continuing basis as the curriculum development was implemented. In addition, in order to obtain even broader input, in the spring of 1978 approximately 70% of the faculty from the Division of Natural Sciences and College of Pharmacy (more than 30 total) attended a three-hour workshop (on Friday afternoon yet!!!) and systematically evaluated all course objectives for the four entry-level sequences. Subsequently, a number of individuals voluntarily met with the various departments for more extensive discussions. This activity not only proved to be extremely valuable in terms of gaining a better perspective of what other departments expected from the entry-level courses in one's own area, but also opened the door for continued communication. It is now much more common to have inter-departmental communication about content and teaching techniques than previously. The success of the first such workshop led to a repeat performance in the fall of 1979 after refinement and modification had been made on the basis of previous evaluation. This workshop, like the first, was very successful.

3. Formative Evaluation by Outside Consultants: In order to ensure that course modification did not result in course content which deviated significantly from that expected in similar courses elsewhere, both years each department sought an outside consultant who spent two days at XU reviewing and evaluating the course materials, and in some cases, delivery system. The outside consultants were:

	1977-78	1978-79
Biology	Dr. John Ruffin Biology Department North Carolina Central University, Durham	Dr. John Ruffin Biology Department North Carolina Central University, Durham

Chemistry	Dr. Theodore Brown Author of Chemistry: The Central Science, the chemistry text at XU Professor of Chemistry University of Illinois Urbana	Dr. Arthur Whimbey Author of Intelligence Can Be Taught & Problem-Solving and Comprehension: A Short Course in Analytic Reasoning Guest Lecturer, XU
Mathematics	Dr. Solomon Garfunkel Associate Director, UMAP Mathematics Department University of Connecticutt Storrs	Dr. Raymond Coughlin Author of Applied Calculus Mathematics Department Temple University
Physics	Dr. Charles A. Pickett Chairman, Department of Chemistry & Physics Mississippi Valley State University, Itta Bena	Dr. Jack Lochhead Director, Cognitive Development Project Department of Physics University of Massachusetts Amherst

Their official reports are contained in Appendices IV-XI.

In addition, at the end of the three-year grant period, Dr. Bobby Irby, Chairman of the Department of Science Education at the University of Southern Mississippi, evaluated the entire project. His report is included in Appendix XVIII. His report concludes with the following statement...

"Progress toward meeting these objectives has been excellent, and where objectives are not yet fully addressed, significant mechanisms have been established that will result in advancement toward meeting them. In short the CAUSE project has been successful."

Summative Evaluation:

The ultimate success of the project must be judged on how well it achieves the stated objectives of decreasing attrition from and improving performance in entry-level courses for science majors at Xavier. The following sections of this report indicates that all four of the departments had success in obtaining these goals. The overall success of the program is substantiated by the report submitted by Dr. Bobby Irby, Chairman of the Department of Science Education at the University of Southern Mississippi after visiting XU as the final, overall evaluator. His report is contained in Appendix XVIII.

Biology

All majors in Biology, Psychology, Medical Technology, Pre-Pharmacy, and Premedicine/predentistry are required to take a year-long entry-level Biology course for science majors. There is no prerequisites for enrollment and no placement exams are given. All departments, however, require that their students make a grade of "C" or better in the course.

The Biology Department made particularly significant progress in improving the course under the CAUSE Grant. In departmental-wide discussions at the beginning of the project, the decision was reached to change entry-level Biology from a semester of General Biology and a semester of Zoology to year of General Biology. Following this decision, materials for the new first semester lecture and laboratory courses, Biology 123 and 123L, were developed in 1977-78 and field-tested in 1978-79. Those for the second semester, Biology 124, were developed and field-tested in 1978-79. (In order to avoid confusion, the new course have new numbers. The old ones had been Biology 113 and 114.) The development and use of CAUSE-funded materials has made it possible for the Biology Department to make good progress toward reducing attrition and outstanding progress in increasing performance as outlined below.

1. Success in Reducing Attrition (Increasing Attrition)--Biology

For all practical purposes a science major who makes lower than a "C" in any science or mathematics course is unlikely to be able to obtain his or her career objectives. In addition, most departments at XU who require science-major entry-level Biology require that the student obtain a "C" in order to use the credit for graduation. It therefore appears that the percentage of students who complete the entry-level courses with a "C" or better is a suitable measure of retention in the sequence (and in science majors at XU). It should be noted that entry-level Biology is only one of the four sequences modified via CAUSE which does not have a prerequisite for entering it and it is therefore unlikely that retention in this sequence will ever reach that hoped for in the other entry-level courses. (Both Precalculus/Calculus I and General Chemistry require that a student pass all or some part of the University's Mathematics Placement Examination or complete a developmental Mathematics course before enrolling in those sequences. Physics requires that students complete Precalculus with a "C" or better before enrolling in entry-level Physics.) The following table contains pertinent data for the entry-level Biology sequence for the past three years.

	Biology 123 (a) Number Entering	Biology 123 (b) Number Pass w/"C"	Biology 124 (c) Number Entering	Biology 124 (d) Number Pass w/"C"	Through-put (% pass in yr = $\frac{d}{a}$ x 100%)
Fall, 1977 (pre-CAUSE)	182* (100%)	116* (64%)			
Spring, 1978 (pre-CAUSE)	68* (100%)	19* (28%)	119** (100%)	89** (75%)	49%
Fall, 1978 (CAUSE)	162 (100%)	81 (50%)	27** (100%)	24** (89%)	35%
Spring, 1979 (CAUSE)	84 (100%)	43 (51%)	99 (100%)	88 (88%)	54%
Fall, 1979 (CAUSE)	185 (100%)	109 (59%)	45 (100%)	41 (90%)	48%
Spring, 1980 (CAUSE)	79 (100%)	41 (52%)	108 (100%)	87 (81%)	47%

*Biology 113 **Biology 114

From the data above, it is obvious that there has been significant progress toward increasing retention in (reducing attrition from) entry-level Biology courses for science majors. Specific observations which are noteworthy are:

1. The percentage of students completing the "off-semester" course in Biology 123 (i.e., in the spring rather than in the fall) has increased dramatically--from approximately 25% to above 50% after implementation of CAUSE. This is particularly significant because off-semester sections have higher percentages of students with known academic deficiencies upon entering the University and correspondingly lower probablility of completing a degree program in the sciences. The course modification undertaken via CAUSE is particularly noteworthy, therefore, to the educationally-disadvantaged, the exact group for whom the development was aimed.

2. The percentage of students completing both sequences (i.e. "through-put") for the off-semester sequence has increased to the point where it is comparable to that for the sequence which begins in the fall. Again, the CAUSE materials were obviously successful since the less well prepared students were those who benefited.

In summary, the attempt to reduce attrition (increase retention) in the entry-level Biology sequence for science majors is successful since it is increasing the number of students (in off-semester courses) successfully completing the sequence.

2. Success in Increasing Level of Performance--Biology

In the spring of 1978 and again at the same time in 1979 and 1980, a randomly-selected sample of students completing the entry-level Biology courses were administered the CLEP General Biology Examination under similar circumstances--in laboratory for a few extra points on such short notice that no preparation was possible. The resulting data is presented below:

	Number	Average Score	Standard Deviation	Range	Approximate %-ile for Average
1977-78 (pre-CAUSE)	39	29.0	3.91	32-46	15th
1978-79 (CAUSE)	29	47.6	7.62	36-64	42nd
1979-80 (CAUSE)	31	45.3	5.87	34-63	36th

This data indicates outstanding success in increasing level of performance!!! Specific comments of note are:

1. The average in both 1978-79 and 1979-80 is as high as (or higher than) the highest score in 1977-78 (pre-CAUSE).

2. The percentile rank of the average score has more than doubled what it was prior to implementation of CAUSE. (Alternately, the percentile rank has increased by more than 20 percentile points after CAUSE as compared to before.)

In summary, Biology has made phenomenal progress in increasing level of performance in addition to the reduction in attrtion discussed in the previous section.

Chemistry

The content of General Chemistry at Xavier has been determined by the entire department (rather than individual faculty teaching various sections) via clearly prescribed content objectives (and finals) for a number of years. Therefore, the Chemistry Department needed less time to consider course content and to develop/modify materials than did the other departments. This, in turn, made it possible to devote more time to refining the existing delivery system. The result is described in "Cognitive Skills Oriented PSI in General Chemistry," Journal of Developmental And Remedial Education, Vol. 3, pages 4-6 (Winter, 1979). A copy of the latter is enclosed in Appendix XXIV. The combination of extensive previous experience in similar activities and an inordinate amount of work during the summer of 1977, yielded sufficient progress in modification/development of new materials to actually begin using them (while completing development one step ahead of need) in the fall of 1977--the first year of the CAUSE grant. While beginning the use of materials before completing development is not recommended for those disposed to ulcers, doing so made it possible for the Chemistry Department to field-test and further refine materials twice during the first two years of the grant. This, in turn, made it possible to make significant progress both toward reducing attrition from and increasing performance in the General Chemistry sequence as detailed in the following.

1. Success in Reducing Attrition (Increasing Retention)--Chemistry

For all practical purposes a science major who makes lower than a "C" in any science or mathematics course is unlikely to be able to obtain his or her career objectives. It therefore appears that the percentage of students who complete General Chemistry with a "C" or better is a suitable measure of the retention in the course. The following table contains pertinent information for the General Chemistry sequence at XU for the past three years.

	Chemistry 101		Chemistry 102		Through-put
	a--Number Entering	b--Number Pass w/"C"	c--Number Entering	d--Number Pass w/"C"	(% pass in yr = d/a x 100%)
1976-77 (pre-CAUSE)	118 (100%)	71 (60%)	69 (100%)	53 (77%)	45%
1977-78 (1st yr. CAUSE)	133 (100%)	91 (68%)	86 (100%)	75 (87%)	56%
1978-79 (2nd yr. CAUSE)	156 (100%)	124 (79%)	105 (100%)	97 (92%)	62%
1979-80 (3rd yr. CAUSE)	109* (100%)	81** (74%)	75 (100%)	61** (81%)	56%

*Enrollment was down because minimum criteria for passing Mathematics Placement Exam at XU, a prerequisite for General Chemistry, was increased. A study in 1979-80 indicated that passing at the higher level made no measureable difference in performance or retention in General Chemistry. Therefore, students with minor deficiencies in math may concurrently enroll in General Chemistry and a one-semester "fast" math review. Those with more serious deficiencies must complete review courses before enrolling in Chemistry.

**A study made in 1978-79 indicated that the refinement of the General Chemistry delivery system had eliminated the need for the "DC = Deferred Credit" Grade which allowed students to take more than one semester to complete a course if necessary. Therefore, the grade was dropped beginning in 1979-80.

From the data above, it is obvious that the attempt to reduce attrition in General Chemistry (to increase retention) was successful. A summary of the data is given in the following:

1. The percentage of students completing Chemistry 101 rose from 60% in 1976-77 (before CAUSE) to an average of 74% after CAUSE-development.

2. The percentage of individuals completing Chemistry 102 rose from 77% before CAUSE to an average of 81% after CAUSE development.

3. The "through-put", the percentage of students who finish both semesters of General Chemistry (a statistic thought to be a good estimate of the percentage who remain in the sciences since General Chemistry is required for almost all science majors at XU) rose from 45% in 1976-77 (before CAUSE) to an average of 58% after CAUSE modification/development.

4. The refinement of the delivery system used in General Chemistry made it unnecessary to retain the "DC = Deferred Credit" Grade which had been used from 1972 to 1979 as a mechanism for allowing poorly prepared students to take more than one semester to complete a given General Chemistry course.

In summary, the attempt to reduce attrition (increase retention) in General Chemistry was an outstanding sucess. Not only did the percentage of students completing the course with a "C" or better increase for both semester but the refinement completed under CAUSE made it possible to eliminate the "Deferred Credit" grade. Further, the increases in retention occurred at the same time that increases in level of performance were occurring. The General Chemistry sequence at XU, as described in Appendices XXIV and XXV, is a good example of the way in which the University implements "Standards with Sympathy"--coupling high academic expectations with mechanisms which allow the educationally-disadvantaged students to succeed.

2. Success in Increasing Level of Performance--Chemistry

For a number of years, students completing Chemistry 101 have taken an examination whose content and format is very strictly specified by the Chemistry Department as a whole. In addition, students completing Chemistry 102 have been required to take various versions of the American Chemical Society's Cooperative Examination in General Chemistry as a final since 1974. This makes comparison of performance from year to year in the two courses relatively reliable. In making such comparisons, however, it should be remembered that one of the features of the modified PSI courses at Xavier is the opportunity for students to repeat finals (other versions--not the same test) as a means of promoting learning to take standardized exams. The following data summarizes the success of XU's CAUSE Grant with respect to increasing level of performance in General Chemistry.

	Chemistry 101			Chemistry 102			
	Number	Mean*	Std. Dev.	Number	Mean*	Std. Dev.	%-ile of Mean
1976-77 (pre-CAUSE)	76	129	26	58	141	37	51st
1977-78 (1st yr. CAUSE)	111	127	29	84	143	40	52nd
1978-79 (2nd yr. CAUSE)	135	137	26	97	146	29	55th
1979-80 (3rd yr. CAUSE)	99	135	27	69	148	32	57th

*For highest grade on the repeatable final.

The data above indicate that the program was successful in terms of increasing performance in General Chemistry as follows:

1. Performance in Chemistry 101 increased slightly over the time period even as percentage of students who completed the courses increased (see the previous section).

2. Performance in Chemistry 101 also increased as percentage of students who completed the course increased.

In summary, the CAUSE Grant resulted in both reduction of attrition from and increase in level of performance in General Chemistry.

Mathematics

All students entering Xavier are required to take a locally-produced Mathematics Placement Examination which determines whether the student must complete a developmental, non-degree credit Mathematics course (Math 0980) before enrolling in regular college courses. The CAUSE Grant focuses on improvement of the two college-credit Mathematics courses taken by most science majors after passing either the Placement Exam or the developmental course. They are Precalculus and Calculus I. The first of these courses is a combination of elements from Algebra and Trigonometry. The second is both a terminal course for most science majors and the first semester of a three-semester sequence for a much smaller number. Development of these courses under CAUSE has been accompanied (as it must be) with corresponding development (from other sources) of both the developmental courses and the remaining two courses in the Calculus sequence. The Mathematics Department has made significant progress in both reducing attrition (increasing retention) and increasing level of performance as is detailed below.

1. Success in Reducing Attrition (Increasing Retention)--Mathematics

It is unlikely that a science or mathematics major who makes lower than a "C" in a science or mathematics course will successfully obtain a career in one of these areas. For that reason, it appears that the percentage of students who complete entry-level courses with a "C" or better is a suitable measure of the retention in the courses. The following table contains statistics for the Precalculus and Calculus I sequence at Xavier for the past three years. It should be noted that the CAUSE materials for Precalculus were implemented during 1978-79 and those for Calculus I were implemented during 1979-80. The table is arranged to facilitate comparing the statistics from one fall semester against another, and likewise for the spring and summer semesters, since in this way we are comparing more homogeneous groups of students.

Mathematics 1030

	(PRE-CAUSE)			(CAUSE 1030)			(CAUSE 1030 & 1040)		
Term	Year	Number Entering	Number (%) Pass w/"C"	Year	Number Entering	Number (%) Pass w/"C"	Year	Number Entering	Number (%) Pass w/"C"
Fall	'77	155	56 (36%)	'78	215	97 (45%)	'79	181	103 (57%)
Spring	'78	122	50 (41%)	'79	134	51 (38%)	'80	165	77 (47%)
Summer	'78	33	6 (18%)	'79	31	17 (55%)			

Mathematics 1040

Fall	'77	71	24 (34%)	'78	90	45 (50%)	'79	78	30 (38%)
Spring	'78	107	50 (47%)	'79	117	73 (62%)	'80	133	68 (51%)
Summer	'78	43	32 (74%)	'79	44	28 (64%)	'80	47	28 (60%)

From the data on the preceding page, it seems that some progress has been made in reducing the attrition rate in the Precalculus course during the three-year span; for example, the percentage completing the course with a "C" or better has increased from 36% in the fall of 1977 to 57% in the fall of 1979. Since the present three class meetings per week in Precalculus does not provide sufficient opportunity for most students to absorb all the algebra and trigonometry needed for Calculus, we expect more improvement in retention when we gain approval to make Precalculus a four semester-hour course.

The increased attrition from Calculus I during 1979-80 seems to be the result of the uniform standards imposed by the modules and common exams. These have led to an increase in content over what many instructors previously included in their Calculus I course and to an increase in expected standards of student achievement by other faculty members. We believe that the attrition rate will decline once all members of the faculty have the opportunity to become accustomed to the new materials.

Physics

Enrollment in entry-level Physics for most science majors (Physics 201 and 202) is lower than in the entry-level courses for the other three departments. Therefore, fewer faculty are involved in teaching the sequence and there are correspondingly fewer problems in coordinating activities associated with the course than there are in Biology, Chemistry, and Mathematics where a sizeable fraction of the faculty are teaching some part of the introductory courses in a given semester. However, course improvement via CAUSE was desirable because many students who enroll in the course, even though better prepared than those entering the other entry-level courses, still have significant deficiencies--especially in problem-solving ability. Materials for Physics 201 were developed in 1977-78 and were field-tested in the summer of 1978. These materials and some part of those for Physics 202 were used in academic 1978-79 as modification and further developed was effected. The full component of CAUSE materials in Physics were used for the first time in the summer of 1979. In the spring of 1979 the decision was made to reduce the number of credit hours in Physics 201-202 from eight to six. Therefore, additional modification was undertaken during the summer of 1979 and during 1979-80 in order to accomodate this change without significantly lowering the quality of the course. Data gather before, during and after the extensive changes which have taken place indicate that the Physics Department has made significant progress both toward reducing attrition from Physics 201-202 and toward increasing level of performance in the courses. The details are presented in the following sections.

1. Success in Reducing Attrition (Increasing Retention)--Physics

In considering retention in Physics 201 and 202, it is assumed that a grade less than a "C" in the course is unlikely to indicate progress toward a degree in a science major. Therefore, the percentage of students who complete the two courses with a "C" or better seems to be a suitable measure of retention for the two. This is the same measure used by the other three departments undertaking course improvement under CAUSE. The following table contains pertinent retention data for Physics 201 and 202 for the past two years.

	Physics 201		Physics 202		Through-put (% pass in yr)
	Number Entering	Number Pass w/"C"	Number Entering	Number Pass w/"C"	
Summer, 1977 (pre-CAUSE)	25 (100%)	23 (92%)	24 (100%)	24 (100%)	
1977-78 (pre-CAUSE)	51 (100%)	30 (59%)	45 (100%)	27 (60%)	53%
Summer, 1978 (CAUSE 201 only)	28 (100%)	19 (68%)	21 (100%)	12 (57%)	
1978-79 (part-CAUSE)	59 (100%)	41 (69%)	63 (100%)	46 (73%)	78%
Summer, 1979 (total CAUSE)	43 (100%)	26 (60%)	28 (100%)	16 (57%)	
1979-80 (total CAUSE)	93 (100%)	61 (65%)	80 (100%)	68 (75%)	73%
Summer, 1980 (total CAUSE)	52 (100%)	33 (64%)	35 (100%)	27 (77%)	

The general hectic pace of summer school and the variation in quality of student who chooses to enroll then makes it impossible to place any faith in observations concerning retention based on comparison of summer school grades. This data is included in the table only to emphasize that materials for both semesters have been developed and field-tested during the grant period. However, the data for academic years indicates the Physics component of XU's CAUSE grant has been successful in reducing attrition as intended.

1. The percentage of persons completing Physics 201 has increased from 59% before CAUSE development (1977-78) to an average of 67% since that development.

2. The percentage of persons completing Physics 202 with a "C" or better has increased from 60% in 1977-78 (pre-CAUSE) to an average of 74% in 1978-79 and 1979-80 (post-CAUSE).

3. The "through-put" in Physics 201-202 in one year has increased from 53% before CAUSE to an average of 75.5% after CAUSE.

In summary, the Physics Department was extremely successful in reducing attrition from entry-level courses as a result of the CAUSE Grant. Further, this is particularly impressive since there was a 25% decrease in lecture hours per week (from eight to six) from 1978-79 to 1979-80. It is obvious that the CAUSE-development was one of the major factors which made it possible to make such a reduction without increasing attrition appreciably.

2. Success in Increasing Level of Performance--Physics

Neither ETS (via CLEP) nor the American Physical Society provide a college-level standardized exam for a non-Calculus based, year-long Physics course. Further, efforts to find a nationally-normed exam from other sources were unsuccessful. Therefore, it was not possible for Physics to obtain direct input concerning level of performance of its students as compared to the national average. However, the department did develop specifications for finals for both Physics 201 and 202 and collected performance data on finals during the grant period. This data is presented below.

	Physics 201			Physics 202		
	Number	Mean on Final	Std. Dev.	Number	Mean on Final	Std. Dev.
AY, 1977-78 (pre-CAUSE)	50	61.8	14.3	44	50.9	13.4
Summer, 1978 (CAUSE 201)	28	71.2	15.6	20	73.0	27.2
AY, 1978-79 (part-CAUSE 201)	59	62.4	15.4	63	62.8	18.3
Summer, 1979 (CAUSE 201 & 202)	43	62.4	14.3	27	64.0	19.7
AY, 1979-80 (CAUSE)	92	63.5	14.8	80	65.2	18.2
Summer, 1980 (CAUSE)	52	63.2	14.3	34	68.2	19.1

Statistics for the summer sessions are included merely to indicate that Physics 201 and 202 materials were developed and used in those courses also. the smaller number of enrollees during the summer and the generally hectic pace of summer schoold tends to give more variation than noted for the academic year. Therefore, only academic year data is used in the analysis. The comments which may be made are as follows:

1. There was a significant increase in performance on the Physics 202 final after CAUSE-development as compared to before.

2. Changing from an eight semester hour to a six semester hour course (in academic 1979-80) did not result in lessening performance on the finals in either Physics 201 or 202. Since the finals from all three years were developed from the same detailed specifications, they are known to be roughly comparable. Therefore, this lack of change is particularly important.

In summary, Physics (like the other three departments) had good success in both reducing attrition from and increasing level of performance in its entry-level courses as a result of XU's CAUSE Grant.

On-Going Evaluation:

One of the primary purposes of Xavier's CAUSE Project was to enhance the ability of the four departments to access performance of students from year to year in an objective manner and to provide guidance to inexperience faculty as they attempt to improve teaching techniques. This effort to improve methods of on-going evalution included a) identifying standardized exams which permit some measure of level of performance locally against that nationally and b) deveioping detailed specifications for locally-produced, common finals for each of the entry-level courses.

All departments have been successful in the attempt to improve their ability to evaluate both students and faculty involved in entry-level courses. First, Biology, Chemistry, and Mathematics (for Precalculus) identified national exams for the entry-level courses in their respective fields and administered those exams both before and after implementing the course improvement under CAUSE. Second, all four departments completed detailed "prescriptions" for common examinations for their respective entry-level courses. Third, all four departments have agreed to continue to use these exams in the future. A detailed plan for the way in which CAUSE-implemented activities will be continued after the grant period is contained in Appendices XX-XXIII.

In summary, the CAUSE Grant to Xavier was successful in terms of its enhancing the four departments' ability to evaluate courses in the future.

V. Dissemination

In the past, those institutions most likely to possess expertise in treating the special problems of minority or educationally-disadvantaged students (for instance, the predominantly-black institutions such as Xavier) have been least likely to develop mechanisms for disseminating that information. Since this both inhibits development through sharing experiences and prevents such institutions from gaining the recognition they deserve, Xavier's science faculty actively sought to share their experiences re CAUSE and related activities. The following is a summary of the dissemination efforts completed or planned by XU faculty.

General

During the Spring semester of 1978, 1979, and 1980 the CAUSE Committee (Carmichael, Hunter, Jones, and Vincent) sponsored a Workshop on Science Teaching and the Development of Reasoning for local high school teachers. The workshop focussed on Piaget's theory of intellectual development and its implications for science and mathematics teachers. Materials for the workshops were purchased from the Reasoning Laboratory at the Lawrence Hall of Science, University of California, Berkeley.

Dr. Carmichael accepted an invitation to attend a conference for representatives from college-level, Piagetian-based programs held at the University of Nebraska--Lincoln in the summer of 1978. The programs represented are discussed in a publication entitled Multidisciplinary Piagetian-Based Programs for College Freshmen which is available from Dr. Robert Fuller, Director, ADAPT, 213 Ferguson Hall, University of Nebraska, Lincoln, NE 68588.

The CAUSE Committee sponsored a "How I do it Workshop" for high school mathematics and science faculty from New Orleans in the Spring of 1979. 37 high school teachers and 14 XU faculty attended.

The CAUSE Committee sponsored a "hands-on" introduction to the graphic terminals purchased via CAUSE (Tektronix and APPLE II) for XU science and mathematics faculty in the Spring of 1979.

The CAUSE Committee sponsored a workshop by Dr. Arthur Whimbey, author of Intelligence Can be Taught (Innovative Sciences) and Problem-Solving and Comprehension: A Short Course in Analytical Reasoning (Franklin Institute Press) in the Spring of 1979. The workshop was designed to generate interest in the use of Dr. Whimbey's "Cognitive Therapy" as a means of improving student performance on standardized exams.

The CAUSE Committee submitted a document discussing Project SOAR to The American Biology Teacher. It was published in March of 1980 (Vol. 42, No. 3, pages 169-173). A photocopy is included in Appendix XVI.

The CAUSE Committee submitted an article discussing the use of Whimbey's "cognitive therapy" as a means of improving scores on standardized exams to The Journal of Reading. It was published in October of 1980 (Vol. 24, No. 1, pages 5-10). A copy is enclosed as Appendix XVII.

The CAUSE Committee submitted an article discussing the "bridge nature" of SOAR (between high school and college) to the Louisiana Journal of Science. The article has been accepted for publication early in 1981.

The CAUSE Committee provided assistance to the Southern Regional Education Board as that organization sponsored Science Instructional Seminars in New Orleans and Durham, NC, in 1979-80. Dr. Vincent, Ms. Hunter, and Sr. Grace Mary Flickinger made presentations at both Seminars.

Dr. Jones, Dr. Vincent, and Ms. Hunter made presentations re XU's Piagetian-based activities at a conference on "Reasoning, Piaget, and Higher Education" at Denver in the Spring of 1980.

The CAUSE Committee assisted Dr. Vincent prepare a proposal to IDSE (NSF) to disseminate information about new ideas for mathematics and science instruction to local junior and senior high school teachers. The project was funded beginning in the fall of 1980 and is proceeding exceptionally well.

Ms. Hunter and Dr. Carmichael discussed the implications of Piaget's theory of intellectual development for science teachers at the National Science Teachers' Association Meeting in New Orleans in the fall of 1978.

Dr. Carmichael was one of six speakers invited by the National Science Foundation to speak at a CAUSE Information Exchange Seminar at North Carolina State University in August of 1979.

XU's CAUSE Project was featured in the last issue of the Association of American Colleges' Forum for Liberal Education in January of 1980.

Forty-three persons have requested information about XU's CAUSE Project and one, Fayetteville State University (North Carolina) will be using the CAUSE-developed General Chemistry Laboratory materials in the spring of 1981. See Appendix XXX for a list of those asking for information.

Biology

Ms. Hunter discussed XU's CAUSE Project at the NSTA meeting in Atlanta in the Spring of 1979.

Sr. Grace Mary Flickinger discussed the Biology portion of XU's CAUSE Grant at a meeting of the National Association of Biology Teachers in New Orleans in the fall of 1979.

Ms. Hunter discussed Project SOAR, XU's multidisciplinary summer program at the National Association of Biology Teachers meeting in New Orleans in the fall of 1979.

Ms. Hunter presented a paper entitled "Mitosis and Meiosis with Knives, Forks, and Spoons" at the National Association of Biology Teachers in New Orleans in the fall of 1979.

Sr. Grace Mary Flickinger discussed XU's CAUSE Project, and particularly the Alternate Pathways Learning Center, at the International Congress on Individualized Instruction in Athens, Georgia, in the fall of 1979.

Ms. Hunter and Sr. Grace Mary Flickinger made presentations at an IDSE-sponsored workshop for local Biology teachers at Xavier in the fall of 1980.

Chemistry

Dr. Carmichael attended the Networks National Conference in San Francisco as an invited speaker to discuss XU's CAUSE-related activities re "Sympathy versus Standards in the Sciences: Overcoming Student Deficiencies" in the fall of 1978.

Dr. Mary Ann Ryan made a presentation as an invited speaker at an NSF-sponsored conference for institutions which had had MISIP Grants to discuss XU's General Chemistry sequence in Washington in the spring of 1979.

An article describing XU's CAUSE-developed General Chemistry course was published in the Journal of Developmental and Remedial Education in the Winter, 1979, issue. A copy is enclosed in Appendix XXIV.

An article describing XU's Piagetian-based (and CAUSE-developed) General Chemistry Laboratory program was submitted for publication to the Journal of Chemical Education. It appeared in September, 1980 (Vol. 57, No. 9, pages 642-645). See Appendix XXV for a copy.

Dr. Carmichael served as an invited speaker at a Networks Conference held in Washington, DC, in the fall of 1979. Both SOAR and the CAUSE-related activities at XU were discussed.

Mr. Donald Robinson made a presentation re XU's General Chemistry sequence and its special features for educationally-disadvantaged students at the National Meeting of the American Chemical Society in Houston in the Spring of 1980.

Dr. Carmichael served as keynote speaker at a session on "Minorities and Women in Chemistry" at the 6th Biennial Conference on Chemical Education in Rochester, NY in June. Sr. Joanne Bauer and Ms. Barbara Wells made presentations concerning XU's CAUSE-developed lecture and laboratory courses at that same meeting in 1980.

Dr. Carmichael has been invited to speak at a number of upcoming events including a symposium for high school teachers sponsored by the Ouachita Valley (Northern Louisiana) Section of the American Chemical Society; the 1981 SE Regional Meeting of the American Chemical Society to be held in Lexington, Kentucky; the March meeting of the American Association for Higher Education in Washington in March, 1981; and a special workshop for educators from California Universities and Colleges in February, 1981.

Mathematics

Sr. Rosemarie Kleinhaus, Dr. Bill Irlbeck, and Mr. Winston Brown discussed XU's CAUSE-developed mathematics materials at the American Mathematics Association of Two-Year Colleges' National Meeting in San Diego in the fall of 1979.

Mr. Lester W. Jones discussed Project SOAR and the implications of Piaget's theory of intellectual development for mathematics teachers at the American Mathematics Association of Two-Year Colleges in San Diego in the fall of 1979.

Mr. Jones served as a consultant for the developmental mathematics program at Tougaloo College, MS, in May of 1980.

Dr. Anthony DuRapau made a presentation concerning XU's CAUSE-developed Mathematics courses at the 4th International Congress on Mathematical Education in San Francisco in August, 1980.

Physics

Dr. Vincent directed the "How I Do It Workshop" for local science and mathematics faculty (from high schools) in the spring of 1979.

Dr. Vincent discussed the CAUSE-developed Physics materials at the Louisiana Academic of Sciences Meeting in Hammond in the Spring of 1979.

Dr. Vincent served as a consultant for the developmental mathematics and science program at Tougaloo College, MS, in May of 1980.

CAUSE Grant SER77-06227 to the Departments of Biology, Chemistry, Mathematics, and Physics at Xavier University of Louisiana was definitely a success!! In the words of Dr. Bobby Irby, Chairman of the Department of Science Education at the University of Southern Mississippi who served as a final, overall evaluator...

"Progress toward meeting these objectives has been excellent, and where objectives are not yet fully addressed, significant mechanisms have been established that will result in advancement toward meeting them. In short the CAUSE project has been successful."

VII . A Footnote

In early 1979, XU was selected as one of a small number of institutions which had received CAUSE funds to be included in a major study of the impact of CAUSE as a whole. As a result of this selection, representatives from Development and Evaluation Associates, Syracuse, NY visited XU's campus a number of times as outlined below:

March 7-8, 1979	Dr. John D. Eggert, Director, Development & Evaluation Associates Ms. Jane Cashell, Assistant Director Dr. James Gallagher, Director, Science & Mathematics Teaching Center, Michigan State University
April 19-20, 1979	Dr. Al Beilby, Syracuse University
February 28-29, 1980	Ms. Jane Cashell Dr. James Gallagher Dr. Al Beilby

In addition to talking with the CAUSE representatives, these individuals also conversed with University administrators and all other faculty within the four participating departments while on campus. They also requested a variety of additional materials, including weekly time-sheets stating time spent on each CAUSE activity, from both the CAUSE Committee and other XU faculty.

Generally, the visitors were well received in spite of the fact that the visits were time-consuming and the additional materials desired was often difficult to obtain. Although the purpose of the study was to evaluate CAUSE rather than XU, Xavier personnel look forward to receiving a copy of the final report.

Appendix I

Enrollment Statistics for the Natural Sciences in Fall Semesters

	1970-71						1971-72						1972-73					
	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot
Biology	3	2	4	11	9	29	7	0	3	5	11	26	8	0	11	4	5	28
Chemistry	12	1	7	10	9	39	10	4	7	6	8	35	20	2	8	4	6	40
Mathematics	6	1	16	12	7	42	10	4	13	12	2	41	11	1	10	11	5	38
Physics	2	1	1	0	0	4	0	1	2	0	0	3	0	0	0	1	1	3
Pre-Engineering	4	4	4	3	0	15	2	2	6	2	0	12	3	0	4	5	0	12
Sub-totals	27	9	32	36	25	129	29	11	31	25	21	117	42	3	33	25	17	120
Medical Tech.							23	5	11	16	14	69	35	5	17	12	14	83
Pre-Pharmacy	20	5	43	--	--	68	20	5	43	--	--	68	41	10	28	--	--	79
Totals							72	21	85	41	35	254	118	18	78	37	31	282
Full-time Undergrad. Enroll.						1308						1351						1341

	1973-74						1974-75						1975-76					
	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot
Biology	8	1	7	7	3*	26*	8	7	5	8	5	33	5	9	6	3	6	29
Chemistry	33	11	18	5	4	71	26	12	14	11	6*	69*	20	8	22	11	9*	70*
Mathematics	9	5	7	7	6	34	9	6	7	6	7	35	5	3	9	1	4	22
Physics	1	0	0	0	1	2	0	0	1	3	1	5	0	0	0	1	4	5
Pre-Engineering	7	0	1	1	0	9	7	3	3	0	0	13	5	5	2	0	0	12
Sub-totals	58	17	33	20	14*	142*	50	28	30	28	29*	154*	35	25	39	16	23*	138*
Medical Tech.	25	8	19	10	10	72	32	17	13	12	11	85	26	17	19	13	10	85
Pre-Pharmacy	39	15	35	--	--	89	62	28	48	--	--	138	61	27	49	--	--	137
Totals	122	40	87	30	24*	303*	144	73	91	40	40*	377*	122	69	107	39	33*	360*
	*@KWilliams in Med.						*@JAllen in Med.						*@Barnum,Doughty,Green					
Full-time Undergrad. Enroll.						1497						1652						1555

	1976-77						1977-78						1978-79					
	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot
Biology	13	3	12	6	6*	40*	29	10	6	7	6	58	37	15	10	6	6	74
Chemistry	31	15	14	17	7*	84*	27	20	22	9	16*	94*	44	20	19	20	9	112
	5	3	5	7	1	21	5	2	4	6	3	20	19	10	2	2	3	36*
Physics	0	0	0	0	2	2	0	0	1	0	1	2	0	0	0	2	0	2
Pre-Engineering	4	2	5	2	0	13	16	4	4	2	0	26	13	8	6	1	0	28
Sub-totals	53	23	36	32	16*	160*	77	36	37	24	26*	200*	113	53	38	31	17	252
Medical Tech.	39	10	20	9	13	81	39	21	21	11	9	101	34	26	19	13	14	106
Pre-Pharmacy	65	31	92	--	--	188	48	37	81	--	--	166	55	39	60	--	--	154
Totals	157	64	148	41	39*	429*	164	94	139	35	35*	467*	202	118	117	44	31	512
	*@Duval, Atkinson, Bowie, Harris						*@Thompson						*c/Comp. Science					
Full-time Undergrad. Enroll.						1612						1519						1615

	1979-80						1980-81						1981-82					
	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot	F	AF	S	J	S	Tot
Biology	46		39	14	7	106	47		47	26	19	139						
Chemistry	43		58	20	17	138	38		43	39	35	155						
Math/Comp. Sci.	39		21	5	2	67	41		39	13	2	95						
Physics	1		0	2	1	4	1		0	0	1	2						
Pre-Engineering	25		11	13	--	49	33		21	11	8*	73*						
Sub-totals	154		129	54	27	364	160		150	89	65*	464*						
Medical Tech.																		
Pre-Pharmacy	57		81	--	--	138	56		121	--	--	177						
Totals																		
							*Includes 8 in Eng. School											
Full-time Undergrad. Enroll.												1640						

Appendix II--A brief overview of CAUSE-sponsored Workshop on increasing scores on standardized exams and a list of participants.

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

INTELLIGENCE IS A LEARNED SKILL. IT CAN BE IMPROVED THORUGH INSTRUCTION.

---so reads the cover of a book entitled Intelligence Can Be Taught by Dr. Arthur Whimbey.

Are you intrigued?

Did you know that Dr. Whimbey is a part-time faculty member in mathematics at XU this semester?

Did you know that he is also the co-author of a workbook designed to be used in TEACHING problem-solving ability?

Would you be interested in learning more?

Plan to attend a special workshop for faculty in the Natural Sciences and the College of Pharmacy which Dr. Whimbey has agreed to conduct on Friday, March 16, from 3 to 6 p.m. in the Gold Room. The event is sponsored as a part of the CAUSE Grant. Ms. Hunter is in charge of the refreshments and exotic entertainment which are rumored to be an integral part of the workshop. Call JWC to reserve a place. It will be necessary to limit the workshop to 25 participants.

Participants:

Biology (XU)
Sr. Grace Mary Flickinger
Ms. Jacqueline Hunter
Dr. Deidre Labat

Chemistry (XU)
Dr. Mary Ann Ryan
Dr. John Sevenair
Sr. Mary Carl Malmstrom
Dr. JW Carmichael, Jr.

Physics (XU)
Dr. Harold Vincent

Mathematics (XU)
Mr. Winston Brown
Sr. Eileen Benton
Dr. Esther Fontova
Mr. Bill Jones
Dr. Bill Irlbeck
Ms. Barbara Irlbeck

Pharmacy (XU)
Dr. Duane Aldous
Ms. Ann Barbre
Dr. Lanny Foss
Dr. Sankar

Computer Sc (XU) Dr. Hassell

Other:

Dr. E. Wesley McNair--Meharry Med.
Dr. John Ruffin--NCCU
Ms. Gail Jones--Delgado
Ms. Jackie Lothscheutz--Delgado
Ms. Linne Hambleton--UNC Medical
Ms. Kathy Travaglini--Parkland C., IL

3/18/79
BY JW Carmichael

Appendix III

THIS WEEK AT XAVIER

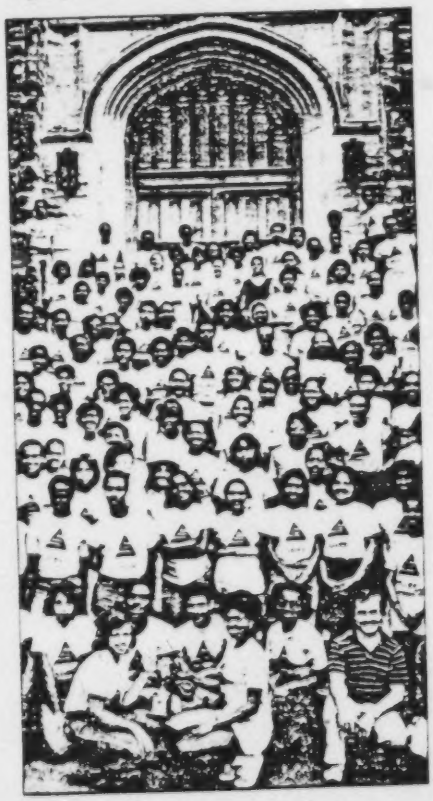
Special Report: Project SOAR

It's a bird! It's a plane. It's Project SOAR - - Xavier's special summer program for pre-freshman science majors, which is soaring to national prominence.

- - **SOAR participants show an overall increase in general intellectual ability upon completing the program.**
- - **SOAR participants with poor reading ability make an average two-year advance in both reading comprehension and vocabulary.**
- - **SOAR participants with low scores on scholastic aptitude tests average the equivalent of a 114-point increase on the SAT.**
- - **SOAR participants are four times more likely to complete their freshman year as a science major than freshmen who did not complete SOAR.**

The sciences at Xavier

In 1976 Xavier University of Louisiana had a full-time enrollment of 1612, with 26 percent of the students majoring in the natural sciences. That same year the Natural Science Division of Xavier, which has an 85 percent black enrollment, made a major new, cooperative effort to increase the University's potential for addressing the national problem of underrepresentation of blacks in the science-related fields.



Four years later it is obvious that the effort has been exceedingly successful. In the fall of 1980 Xavier's total enrollment stands at 2003, and more than 40% of these students are natural science majors. This increase in enrollment in the natural sciences has been accompanied by dramatic increases in placement of graduates in science-related fields. Over the past two years approximately 140 science students have been accepted into health professional schools or science graduate programs.

A major contributor to this success has been the very first cooperative endeavor undertaken - - the development of Project SOAR (Stress on Analytical Reasoning), a special six-week summer program for pre-freshman science majors by the Departments of Biology, Chemistry, Mathematics/Computer Science and Physics/Pre-Engineering, directed by JW Carmichael, Jacqueline Hunter, Lester Jones and Harold Vincent.

Project SOAR: an overview

Project SOAR is comprised of three components - - Piagetian-based laboratory experiments to improve general problem-solving skills, specific instruction to improve those analytical reasoning/reading skills needed on standardized exams and vocabulary building. Teachers in the program are a combination of regular science and mathematics faculty from Xavier, high school teachers and Xavier-educated medical and dental students.

Over the past four years 419 students have completed the SOAR program - - 57 in 1977, 109 in 1978, 113 in 1979 and 140 in 1980. Of this number, 390 were high school graduates who indicated a desire to enroll in a science the following fall, and 29 were 12th graders with similar interests. All of the latter participated in Summer 1980 in a special experimental portion of the program.

To provide the individual attention which is the corner stone of Xavier's success, each year the participants were divided into groups of approximately 25 students, and a medical or dental student was assigned as group leader/mentor/role model/parent image, etc. This group leader not only guided the SOAR students through the various components of the program, but also organized social activities and worked to motivate each student to maximum achievement.

Learning-by-doing promotes thinking

The first of three components of SOAR are 20 three-hour Piagetian-based laboratory exercises. Each is organized as a *learning cycle* containing exploration, invention and application phases. This organization is employed because studies indicate

WE'RE NUMBER ONE: Kelly King and Don Johnson, joined by fellow students during Summer 1980, assure the photographer that they're the tops in a SOAR competition. During the six-week program, Friday afternoons are given to group competition as motivational force.

that as many as 50 percent of college students in the U.S. cannot reason abstractly (at Piaget's formal level) in the manner needed for science or mathematics courses and that the learning cycle - - learning-by-doing - - actually promotes development of abstract learning. The original format was developed by Dr. Robert Karpus, dean, Graduate School of Education, University of California-Berkeley, based on his own experimental work with the theory of intellectual development postulated by Swiss epistemologist Jean Piaget.

Of the 20 such learning cycles used in SOAR, five each are from biology, chemistry, mathematics and physics. They have been developed by Xavier's faculty as units which stress five major components of problem-solving. These are abilities to (a) identify and control variables, (b) use proportional reasoning, (c) consider exhaustively all combinations of factors, (d) use probabilistic relationships and (e) recognize correlations between variables.

The laboratories are conducted by a combination of Xavier science/math faculty and high school teachers. The prevailing atmosphere within each classroom is one of cooperative group effort to solve a problem, with the teacher circulating throughout the room, continually asking questions which require students to verify, further test and devise additional experiments or further extend his/her knowledge. Great care is taken to avoid lecturing and to answering questions in a manner that always requires additional thought.

Intelligence *can be* taught

The second component of SOAR specifically attempts to teach the type of step-by-step logical reasoning needed to perform well on standardized aptitude exams. The teaching method used is the "cognitive skills approach" espoused by former Xavier faculty member Dr. Arthur Whimbey, author of the book, "Intelligence Can Be Taught," and "Teaching Sequential

IT'S A FIT: Arthel Neville gets some help in trying on the SOAR T-shirt from fellow SOAR student Conchetta White. Neville, who has since enrolled in pre-pharmacy at Xavier, also works as a model. You'll agree that White is pretty enough to model.

TIME TO THINK ABOUT TOMORROW: Assistant Pre-Health Advisor Linda Montegue discusses career plans with Andre Buck, Mobile high school graduate who has since enrolled at Xavier. Career counseling is made available to all students in the summer program.

I THINK WE'VE GOT IT: New Orleans area high school graduates Kim Dunn and Charles Valteau, enrolled in SOAR 1980 seem pleased with their lab work. The two are graduates of Xavier Prep and Brother Martin High School, respectively. (Photos by Huard)

Thought: The Cognitive-Skills Approach," *Phi Delta Kappan* (December 1977). The cognitive skills approach assumes that analytical reasoning is a skill of the same general sort as hitting a golf ball, swimming, etc., and that *it can be taught in the same manner*. This represents (a) demonstrating the skill in detail and then (b) requiring the student to practice while monitoring performance. This approach, while very common sense, has not been widely recognized previously, because thinking, unlike hitting a golf ball, takes place within one's head and cannot be easily monitored.

Further, the problem is compounded by our tendency to view "ability to work problems rapidly" as *good* problem-solving, when, in fact, good problem-solving is more accurately characterized by careful, slow analysis, with frequent checking for mistakes.

In SOAR, students are first introduced to the approach as a group by Xavier-educated medical or dental leaders serving as group leaders. They are then carefully monitored while paired as *problem-solver* and *listener* in practicing its use. Ninety minutes are devoted to this approach Monday through Thursday throughout five working weeks of the six-week program. Half of the time is spent on quantitative problems, and half is spent on verbal ones.

"Problem-Solving and Comprehension: A Short Course in Analytical Reasoning" (Whimbey and Lochhead, Franklin Institute Press, 1979) is used as the primary text for the first third of the program. A workbook, "Algebra - - An Introductory Course" (Bramscom, AMSCO Publications) is used in the quantitative portion, and selections from the ETS Graduate Record Examination Information Bulletin, the American Dental Association's Dental Admissions Test Preparation materials, etc. are used on the verbal section. All cognitive skills instruction is conducted by group leaders after training by and with supervision from Xavier faculty skilled in the approach.

Vocabulary-building: it can't be avoided

Since vocabulary is a prerequisite to good reading comprehension, a vocabulary-building component is built into SOAR as the third unit. Vocabulary-building drills are conducted for 30 minutes Monday through Thursday by group leaders.

Motivation by group competition

Since students are seldom enthusiastic about building reading or vocabulary skills, carefully controlled competition between the different groups is used as motivation. The competition consists of an hour-long written test, covering the previous week's work in both analytical reasoning (euphemism for cognitive skills training) and vocabulary and a short quiz bowl. All students are required to take the written exam on Thursday afternoon. The exams are graded overnight, and the scores for the various groups are tallied. The results are not announced until Friday afternoon after four students from each group have represented their group in the quick-answer quiz bowl.

At the conclusion of the quiz bowl, scores from the written tests and the quick answers of the quiz bowl are added and - - with great fanfare - - a special SOAR trophy is awarded for the week to the group with the highest score. Points are purposely scaled so that the performance of the group as a whole on the written test is a major factor in determining the winning group, with the quiz bowl serving merely to stimulate interest and generate spirit among the remaining members of the group, who act as a cheering section for their representatives on the four-member quiz bowl panel.

Efforts are purposely made to use the group spirit to facilitate the paired problem-solver/listener arrangement used in the cognitive therapy approach so that the students who score well willingly work with those who have done less well *for the good of the group*.

Project SOAR in more detail

Project SOAR has received national attention among educators as the result of having been featured, among a select number of interdisciplinary programs, in a series of reports on teaching in *Change* magazine in 1978 and by being included in an article on Piaget's legacy in American education in *The Chronicle of Higher Education*, Sept. 1980. Details of the program have also appeared in "Project SOAR (Stress on Analytical Reasoning): A Multidisciplinary Summer Program for Minority Science Students," *The American Biology Teacher*, March 1980, and "Teaching Critical Reading and Analytical Reasoning in Project SOAR," *Journal of Reading*, October 1980.

Related activities at Xavier University

The efforts initiated by the natural science departments with SOAR have spawned numerous academic year spin-offs. The obvious success of SOAR led to a follow-up mulitidisciplinary effort to modify entry-level courses in biology, chemistry, mathematics and physics to reduce attrition and increase level of performance. This effort has now been completed with similar success. Description of two parts of this endeavor may be found in "Cognitive Skills Oriented PSI in General Chemistry," *Journal of Developmental & Remedial Education*, Winter 1979, and "A Piagetian-Based General Chemistry Laboratory Program for Science Majors," *Journal of Chemical Education*, Sept. 1980.

Appendix IV--Schedule & Report of Dr. John Ruffin after consulting with Biology Department

Schedule of Activities
Dr. John Ruffin
Consultant to Biology Dept., CAUSE Grant

Thursday, February 23, 1978

Time	Activity	Place
8:30 a.m.	Meet with Mrs. J. Hunter and S. G. M. Flickinger	Admin. Bldg. Room 320C
9:00 a.m.	Meet with Dr. Ashman	Admin. Bldg. Room 322
9:15 a.m.	Tour the Biology Dept.	
9:30 a.m.	Review Materials	Admin. Bldg. Biology Learning Center
11:00 a.m.	Seminar	Admin. Bldg. Room 212
12:00 p.m.	Lunch	
2:00 p.m. - 4:00 p.m.	Review Materials	Biology Learning Center

Appendix IV (continued)

Friday, February 24, 1978

Time	Activity	Place
9:00 a.m.	Meet with Sr. M. Veronica, University Dean and Sr. Miriam Francis, Dean of College of Arts and Science	Admin. Bldg.
10:00 a.m.	Meet with Dr. N.C. Francis, University President	Admin. Bldg.
11:00 a.m.	Meet with Dr. J. W. Carmichael	Chem. Bldg.
12:00 p.m.	Lunch	
1-3:00 p.m.	Written Report	Biology Learning Center

Appendix IV (Continued)

NORTH CAROLINA CENTRAL UNIVERSITY
DURHAM, NORTH CAROLINA 27707

DEPARTMENT OF BIOLOGY

March 22, 1978

Sr. Grace Mary Flickinger, S.B.S.
Assistant Professor
Department of Biology
Xavier University of Louisiana
New Orleans, Louisiana 70125

Dear Sister Grace Mary:

My determination to do a thorough review of the revisions proposed for your introductory biology course accounts for the delay in my response. I have now read the report and after doing so I am convinced that there are few suggestions that I could make that would strengthen your proposal for this course in any substantial way. You and Mrs. Hunter obviously spent many long hours planning and I am sure that the conclusions I have reviewed are the results of your classroom experiences with the General Biology course. I must say that your experiences obviously parallel my own for I agree in toto with your plans. As a matter of fact, the Biology Department here at North Carolina Central is now using the two semester General Biology approach and finding it to be a much improved way of handling the introductory course as opposed to the one semester sequence. For sure, this system allows for a more in-depth approach and I feel the benefits will be obvious and will manifest themselves through student performance in upper level courses.

The topics to be covered are sound for an introductory level course. The organismal approach to be employed is logical and should make it easier for teachers to move more directly from one living system to another. Your approach will certainly launch a balance attack on both plant and animal systems and I am certainly in favor of this, particularly, since plant systems are usually covered in only a cursory manner in most general biology courses or in some cases completely omitted. I am pleased to say that it appears now that large numbers of biology departments are now aware of this deficiency and, as you are doing, are taking steps to solve this problem.

I noted that no time table was given for the concepts you plan to cover. This is a matter to which you may want to give quite a bit of attention. As I have indicated, the concepts are sound but failure could result by allowing one area of biology (or discipline) to receive more than its fair share of attention at the expense of the other areas. I am sure this is a common observation but one which all of us involved in general biology courses all too often overlook.

Again, I feel that you and Mrs. Hunter are definitely on the right track by initiating a two semester in-depth approach to the teaching of introductory biology and the concept proposed I am sure will lay a foundation for a better understanding of living systems. If I can be of further assistance to you as for as outling more specific behavioral objectives, please feel free to call me at any time.

Thanks again for allowing me the opportunity of looking at Xavier's Science Program "close-up" and I do want you to know that I am thoroughly encouraged by all I saw.

Yours sincerely,

John

John Ruffin, Ph.D.

Appendix V--Schedule for Dr. John Ruffin & Report of Trip as Consultant to Biology Department

Schedule for Visit

by

John Ruffin, Ph.D.

Associate Professor of Biology North Carolina Central University

to

Evaluate Biology Component of CAUSE

Thursday, March 15, 1979

9:00 - 10:00	Sr. G.M. Flickinger and Mrs. J. Hunter	Room 320 Admin. Bldg.
10:00 - 11:00	Biology Tutors	APLC
11:00 - 11:50	Seminar	212 - Admin. Bldg.
12:00 - 1:30	Lunch	
1:30 - 2:00	Dr.Carmichael	MSL
2:00 - 2:30	Dr.Ruby	306A - Admin. Bldg.
2:30 - 4:00	Free time to Review Materials	

Friday, March 16, 1979

9:00 - 10:00	Students	APLC
10:00 - 11:00	Mrs. J. Hunter and Sr. G.M. Flickinger	320 Admin. Bldg.
11:00 - 12:00	Free time	
12:00 - 1:00	Luncheon Meeting - Members of Freshman Studies Committee of Biology Department	
1:30 - 2:00	Wrap - up	320 Admin. Bldg.
2:00 - 4:00	Free time to write report	

Appendix V (continued)

NORTH CAROLINA CENTRAL UNIVERSITY
DURHAM, NORTH CAROLINA 27707

DEPARTMENT OF BIOLOGY

March 27, 1979

Sr. Grace Mary Flickinger, S.B.S.
Chairman
Department of Biology
Xavier University of Louisiana
New Orleans, Louisiana 70125

Dear Dr. Flickinger:

My sincere thanks to you and Mrs. Jacqueline Hunter for the hospitality shown me during my recent visit to Xavier. Participating with the two of you in an evaluation of the Biology component of your Cause Program was indeed a pleasure.

It is always a pleasure for me when I am called upon to evaluate or critique a curriculum or program that is as well orchestrated as yours. Xavier is indeed fortunate to have the kind of visible leadership shown by you, Mrs. Hunter and Dr. Carmichael.

I feel that the objectives of your program are presently being realized. This was evident to me in conversations that I had with many of your students while there. My visit to the APLC was most impressive. The APLC appears to be well equipped with audio visual materials which should assist the students in the Biology Block tremendously in understanding the material presented in class. The caliber of your tutors and the attention and supervision given them by the participating faculty to insure that they impart the very best to students is most complementary.

My visit with Dr. Carmichael was simply stimulating and rewarding. The energy and time that he devotes to the total program will insure its continued success.

The manner in which the Biology faculty works to insure continuity in Biology 124 Block is most advantageous. There was no doubt in my mind that they are receiving not only uniform but quality theoretical and practical experience from this course.

NORTH CAROLINA CENTRAL UNIVERSITY IS A CONSTITUENT INSTITUTION OF THE

My only suggestion would be the incorporation of more native materials in the laboratory aspect of the course. It is my belief that by so doing you may provide a better handle on the fourth course objective listed in the course syllabus. This can be achieved very easily, as we discussed it during my visit. Again, as I indicated to you, please feel free to call on me for any suggestions in carrying out this phase of your program.

My opinion on Biology 124 is that this program is well orchestrated and participating faculty members are well in tune with each other. You are doing a fantastic job at Xavier in training students in basic principles of Biology and the results, I am sure, will be obvious in years to come.

Sincerely,

John Ruffin

John Ruffin, Ph.D.
Professor of Biology

Appendix VI--Schedule of Visit by Dr. T. L. Brown and copy of his report as consultant to Chemistry Department

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

Schedule for Dr. T. L. Brown, Consultant for

the Chemistry Department under XU's CAUSE Grant

Monday, March 6

9:00- 9:15	Meet Ryan, Robinson, Carmichael	Chemistry Building
9:15- 9:45	Meet remainder of Chemistry Faculty	Chemistry Building
9:45-12:00	Review General Chemistry Materials	Despinasse Room
12:00- 2:00	Lunch	
2:00- 5:00	Review General Chemistry Materials	Despinasse Room
7:00- 9:30	Dinner with Ryan, Carmichael, & others	

Tuesday, March 7

9:00- 9:30	Meet with Deans	Dean's Office
9:30-10:30	Visit General Chemistry Drill	MSL
10:30-12:00	Complete Review of Materials	MSL
12:00- 1:00	Lunch	
1:00- 5:00	Written Report	Media Center

Dr. Brown is Professor of Inorganic Chemistry at the University of Illinois at Urbana-Champaign. He is the author of the textbook currently being used in General Chemistry.

Appendix VI (continued)

Evaluation of General Chemistry Course
at Xavier University of Louisiana

During a two-day visit in March, 1978, I was able to observe the operation of the general chemistry program at Xavier University. The following are offered by way of summaries of observations, judgments regarding effectiveness, and so forth, and suggestions for change where these seem appropriate.

1. Extent of Coverage

The amount of material treated in the full year-long program is adequate. The balance between Chem 101 and Chem 102, the first- and second-semester courses, respectively, seems a little light on the Chem 101 side. However, this is no doubt due in part to the need for a unit on the use of a calculator, and the need for some math review at the beginning of the course.

The coverage in the second semester is adequate. The absence of a module dealing explicitly with organic or biochemistry is understandable in light of the fact that most of the students are scheduled to take organic chemistry as a later course. Overall, the year-long sequence seems a bit light on descriptive chemistry. I would suggest that the optional module X include only chapters dealing with descriptive materials. This would mean deleting 9B, on Molecular Orbitals.

As a general comment, I would say that the total content is comparable to that in the general chemistry course offered in other colleges and universities. For example, the sequence and scheduling of chapters is not far different from that at Tulane University, where the same textbook is employed in the general chemistry course.

2. Learning Strategies

I was not able to observe a lecture. The structure and scheduling of the lectures seems appropriate in relation to other course elements.

The drill section I observed seemed to go quite well. I saw extensive discussion between students, and between students and Learning Assistants (LA) or senior faculty. The transfer of error-free information from learning assistants to students is controlled to an extent by providing the LA's with a completed workbook. Still, some range of judgment is required to properly grade tests. Without question the LA's can benefit from the responsibility. In general, the strategy of employing students to help teach students seems quite effective.

The Handbook is well-written. It contains a thorough, clear description of the course structure, grading system, and rules of course operation. Each module is represented by a detailed list of learning goals keyed to the text. The sample problems are keyed to the learning goals. This is an effective means for ensuring that students can evaluate their own ability to attain a particular learning goal. It would be desirable in addition to carry the student one stage beyond this, by exposure to problem material which is not specifically identified in relation to a particular learning goal, or in which more than one learning goal is embodied in a particular problem. However, it must be recognized that only a fraction of the students would be able to handle this higher level of material; it needs to be provided as enrichment rather than essential course content.

The tape programs seem to be moderately popular. It is difficult to assess their effectiveness. They probably are of help to students with reading difficulties. With the present course structure, the audio-tutorial materials simply reiterate the standard course materials. That is, no new materials are introduced in this mode. Efforts to help students overcome reading disabilities should help obviate the need for the tapes.

3. Faculty, Teaching Personnel

The faculty are able and enthusiastic. The considerable success of the program is clearly due to the extensive investment in time made by the faculty, particularly Dr. J. W. Carmichael.

Use of the more advanced undergraduates as resource persons seems to be a successful strategy. However, the competition for the Learning Assistants' time between their own course work and their teaching schedules does apparently create problems at times.

4. Facilities

The physical facilities available for the program are quite inadequate. The Modular Learning Center is presently in very small quarters in an old "temporary" building. However, the persons involved in the program have worked very successfully within the scope of the available facilities, and are operating a very successful program.

5. Lab Facilities and Course Work

The lab facilities for general chemistry located in the pharmacy building are quite satisfactory for lab work, aside from a shortage of hoods. I was unable to evaluate the lab program itself, but there is clearly a strong faculty commitment to developmental work in this area.

6. Student Attitudes

Discussions with several students currently enrolled in both Chem 101 and Chem 102 have given me a reasonably good basis on which to assess student attitudes. I was quite impressed with the high student morale and generally very positive attitude toward the chemistry course. The students feel that they can learn chemistry, that deficiencies in their backgrounds can be overcome. Many of them seem willing to work hard to do

well in the chem courses. These attitudes are engendered in large part by the evident enthusiasm and dedication of the faculty, and extensive faculty-student contact.

7. General Recommendations

The program as it now operates is clearly quite successful in producing a larger number of students better prepared to go on past general chemistry with their science education. Aside from the particular strategies employed, the success of the program suggests that extensive faculty-student contact in a learning environment which the student perceives as responsive and sympathetic can produce important improvements in learning rate. However, it requires an extensive commitment of time and energy on the part of able teachers.

It seems clear that keeping up with the schedule is a major factor in achieving success in the course. A student may fail to keep up simply because of an incapacity to meet the demands of all his/her courses. On the other hand, a student might fall behind because of poor time management, or with the mistaken supposition that catching up will not be difficult. It would be useful, I think, to look for additional, more formal ways to encourage and motivate students that show signs of falling behind. Perhaps some kind of "buddy" system, involving temporary assignment of an LA to a specific student, would help.

Appendix VII--Schedule of Visit & Copy of report of Dr. Arthur Whimbey as consultant to Chemistry Department

Xavier University of Louisiana

NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

Schedule for Dr. Arthur Whimbey, Consultant for the Chemistry Department under XU's CAUSE Grant

Tuesday, March 13, 1979

1:00 - 2:00 p.m.	Dr. Ryan & Dr. Carmichael	Chemistry Building
2:00 - 5:00 p.m.	Visit General Chemistry Drill with Sr. Joanne Bauer	Chemistry Building

Wednesday, March 14

11:00 - 12:00 p.m.	CAUSE Committee & Chemistry Faculty	Chemistry Building

Thursday, March 20

1:00 - 5:00 p.m.	Followup discussions with Dr. Ryan, Dr. Carmichael, & other faculty teaching General Chemistry	Chemistry Building

Report Due: May 15, 1979

Dr. Whimbey is the author of Intelligence Can be Taught published by Innovative Sciences, Stanford, Connecticutt, as well as a number of pertinent articles. He was chosen as a consultant for CAUSE because of the attached article describing ways of modifying PSI courses to make them more accessible to developmental students. The article was published in The Journal of Developmental and Remedial Education, Volume 2, Number 2.

Evaluation Of Chemistry 101-102 At Xavier University In New Orleans

Evaluator: Arthur Whimbey Spring 1979

Persons responsible for designing and conducting the course.
JW Carmichael, Dept. of Chemistry, Xavier Univ.
Mary Anne Ryan, Dept. of Chemistry, Xavier Univ.

Chemistry 101-102 at Xavier University is conducted in a modified PSI format. The modifications have been introduced to meet the needs of the educationally disadvantaged students who form a significant percent of the population (primarily minority) served by Xavier.

Through several years of teaching and educational research, Carmichael and Ryan have identified both the strengths of PSI for educationally disadvantaged students, but also special problems of such students which call for modifications of standard PSI. These observations have recently been confirmed by other educators in various academic disciplines (Cross, 1976; Whimbey, Boylan & Burke, 1979). The special problems include: 1. The procrastination problem; 2. Difficulties in reading and independent learning; 3. Math deficiencies; 4. Lack of laboratory experience; 5. Lack of problem-solving skills and formal reasoning.

Course Materials

1. Chemistry: The Central Science, Brown and Lemay.
2. General Chemistry Handbook, Carmichael and Ryan
3. Organic Chemistry Molecular Models
4. Audio Tapes to supplement the text and lectures, and to prepare students for the laboratory activities. Some produced by professor Carmichael, others purchased.
5. Calculators with logs, sines and scientific notation available for students to use.

6. Standard chemistry laboratory equipment.

7. Computer??

Course Structure

1. Two 1-hour lectures per week.

2. One 3-hour cognitive therapy-oriented drill per week.

3. One 3-hour Piagetian-oriented laboratory per week.

4. One full-time General Chemistry Tutorial Director providing individual assistance as needed.

Course Format

The "Handbook" by Carmichael and Ryan, composed of lecture/text modules and laboratory modules, plays a central role in the course. Lecture/text modules contain clearly written objectives, assignments in the textbook, sample problems and other learning activities. In interviews, students reported they did take the time to read the objectives. They said the objectives and sample problems showed them exactly what they would learn in each module.

The laboratory modules, which alternate with the lecture/text modules, must be completed by students before they begin the corresponding lab experiments. These modules prepare students to conduct the experiments effectively and with understanding.

When asked about the textbook by Brown and Lemay, students reported that by and large they found it satisfactory. Many said they did at times need additional explanations and then turned to the audio tapes produced by professor Carmichael, which were available at Xavier's Alternate Paths Learning Center. All students expressed strong satisfaction with the tapes.

Although scheduled lectures are not a part of standard PSI, lectures have been retained in this course to offer students an additional source for learning as well as a guiding and pacing device; and while attendence is not required, records show 50% attendence at lectures.

The laboratory experiments have been designed in a Piagetian framework of providing concrete experiences for the abstract concepts discussed in the text and lecture. For this reason the laboratory modules are interspersed with the lecture/text modules in the Handbook, insuring that appropriate concrete experiences always precede the formal introduction of new concepts.

The 3-hour weekly drill sessions are used for administering quizzes and for cognitive therapy-oriented tutoring to teach both chemistry content and thinking skills.

Whereas the total registration for Chemistry 101-102 is generally 180-200 students per semester, drill sessions are limited to only 25 students and staffed with an instructor and one or two advanced students called "learning assistants." Students are encouraged to prepare for quizzes before coming to the drills and are allowed only 20 minutes for review and tutoring before starting a quiz. When the quiz is completed, the student takes it to an instructor or learning assistant for scoring. As is standard in PSI, the student has an opportunity to engage in additional study and then take another form of the quiz if his score is unsatisfactory. Because there are at most 25 in the sessions with an instructor and 1-2 learning assistants, an appreciable amount of time and personal attention can be given to students with learning difficulties.

Learning assistants have been trained to engage in "cognitive therapy" tutoring rather than "show-and-tell" tutoring. They do not just give answers or demonstrate the way a problem can be solved. They help students find answers for themselves. This may mean guiding

a student in carefully reading a section of the text. It frequently involves asking a probing question which suggests the way a problem can be solved or a conclusion reached from knowledge available to the student. Also, students are frequently asked to explain all their steps in reaching an answer, especially if the answer is wrong, but whenever the tutor suspects that a student's understanding of a topic is insecure. In demonstrating how a particular type of problem is solved, the tutor may instruct the student and provide explanations, but he allows the student to actually carry out the activities and computations. The tutor seldom carries out all the activities, leaving the student to just watch. After helping a student solve a problem, the tutor asks the student to solve one or more additional problems and to explain his steps as he procedes. Throughout tutoring, the tutor constantly watches for instances where a student arrives at an answer without sufficient concern for accuracy, reasons or necessary cognitive steps. The tutors understand that their goal is to teach chemistry, but also to eliminate the student's need for tutoring.

A special grading system is used in the course which discourages procrastination, yet accomodates students who require more then a semester to complete the course. If a student has not completed all the requirements by the end of the semester but has made reasonable progress, he may receive a grade of DC (deferred credit) which allows him to continue with the remaining modules the next semester. However to discourage procrastination, students are told they must attend 75% of the labs and drills to be eligible for a DC. Also, each student's progress is posted promptly in the main office, and students who fall behind are sent reminders in the mail.

To alleviate the math difficulties educationally disadvantaged students may experience in chemistry, review modules on algebra,

graphing, significant figures, quadratic equations and logarithms are included in the Handbook just prior to topics requiring this math. Also, students are provided calculators to reduce computational labor and error.

Student Evaluation And Performance

Students are required to score 90% correct to pass each module quiz, a higher criterion than usually employed in PSI, even with educationally advantaged students. (The quality and thoroughness of the quizzes can be seen from the samples in the Handbook.) The fact that this criterion is attained speaks to the effectiveness of the Handbook, audio tapes, Piagetian labs and drills in teaching the concepts and principles of chemsitry.

Many educationally disadvantaged freshmen and sophmores have no idea how many hours good students spend studying and reviewing for final examinations. Many have never known the experience of being really prepared for a final exam. Recognizing that, the course allows students 3 attempts in preparing for and taking the final. This not only increases the course's major product--amount of chemistry learned by students who need a background in chemistry as part of their professional training--with little increase in the course's cost. It also seems to be part of a rewarding academic experience students find in the course, as evidenced by the increase in the number of students who change their major to chemistry after taking the course as it is now taught, compared to the number changing when the course was taught in the traditional manner. Furthermore, 83% of the students felt they learned more (and worked harder) in the present course then they would have in a traditional course. Indeed, scores on the ACS Cooperative

Examination For General Chemistry have jumped 17 percentile points since the changeover to modified PSI.

A number of departments at Xavier University are moving in the direction of cognitive process instruction, with greater emphasis on nurturing analytical reasoning. Chemistry is one of the leaders in this move, and studies at other universities (Peleg & Adler, 1977; Sadler, 1979) suggest that student performance in Chemistry 101-102 may improve still further as other freshmen and sophmore courses incorporate Piagetian and cognitive therapy methods to teach analytical reasoning and learning skills.

Appendix VII (continued)

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Whimbey, A., Boylan, H. & Burke, R. "Cognitive Skills-Oriented PSI For Developmental Students," Journal of Developmental & Remedial Education, 1979, 2, 7-10.

Appendix VIII--Schedule of Visit and Report from Dr. Solomon Garfunkel, Consultant to Mathematics Department.

MAY 8 - 9, 1978

SCHEDULE FOR DR. SOLOMON GARFUNKEL,

CONSULTANT FOR THE MATHEMATICS PORTION

OF XAVIER'S NSF - CAUSE GRANT PROJECT

May 8, 1978		MONDAY
9:00 -	9:30	Pick up at Bourbon-Orleans and ride to Xavier
9:30 -	11:00	Meet with Mr. Jones and Mathematics Faculty Individuals
11:00 -	12:00	View of Campus
12:00 -	1:30	Lunch
1:30 -	2:00	Meet with Sr. Miriam Francis
2:00 -	2:30	Meet with Sr. Rosemarie
2:30 -	3:00	Meet with Dr. Carmichael
May 9, 1978		TUESDAY
9:00 -	9:30	same as Monday
9:30 -	10:30	Mathematics Group Faculty Meeting
10:30 -	12:00	Mr. Jones and Dr. Irlbeck
12:00 -	1:30	Lunch
1:30 -	5:00	Free time for Dr. Garfunkel to write sketch of report

Dr. Solomon Garfunkel
Department of Mathematics
University of Connecticut
Storrs, CT 06268

Appendix VIII (continued)

EVALUATION REPORT

In May of 19[illegible], I spent two days with the faculty and staff at Xavier University studying their basic mathematics offering. I was during that time able to speak with the mathematics department as a whole as well as with members of the computer science department, chemistry department and administration. While my specific charge was to evaluate the work done on mathematics 103(pre-calculus), I feel that this can best be done in the context of the other basic courses.

Math 103

Overall, I feel that a yeoman,s job has been done in the preparation of the materials for this course. The study guides are clearly written as well as the sample test material. Care has been given to provide a large number of contact hours for students to receive help from faculty and testing center personnel. The materials have been prepared with an eye toward self-pacing, although they are presently taught in a lecture format.

My only criticism is that the coverage may be too extensive in a three credit course for the designed audience. The most natural solution and one I strongly recommend is to make this a four credit course. It is my understanding that as an administrative matter this may take some time to effect. I would therefore like to make the following interim suggestions:

1. Create two tracks in Math 100, one for those going into 103 and o ne for those not continuing.

2. For those students in the 103 track add to the Math100 syllabus the

materials from modules I and II of Math 103(specifically, module I objectives 1 thru 11 and module II objectives 1 thru 9).

3. Shorten the present module III in Math 103, eliminating objectives 11 thru 14.

4. In module V, teach synthetic division for real factors - objective s 1 and 2. The rest of the material in this module may be dropped or simply summarized.

5. It is essential that the trigonometry in modules VII and VIII be included. If necessary this material should be introduced earlier to insure that it is not left off at the end of the course.

Math 104

Math 104 is presently taught as a standard first semester calculus course. However, this course is in fact a terminal one for approximately 120 out of 150 students. I strongly suggest that this course be broadened to include the calculus of exponential, logarithmic, and trigonometric functions. This can be done by taking a less rigorous approach to limits, continuity, etc. Some excellent texts already exist which take precisely this approach.. Math 207 could easily pick up the added rigor for those students going on in the calculus sequence.

As I have indicated, I feel that the program is proceeding quite well. There are however a few comments and suggestions which I feel will help the overall growth of the program.

1. In courses which have been carefully prepared by objectives, it would be helpful if final exams were standardized relative to these objectives. While I do not recommend common finals, I do feel that questions geared to common objectives would be helpful to both students and faculty and will aid in the evaluation of new course materials.

2. After new modular materials have been developed, it would be useful to obtain student line reviews. Faculty peer reviews often miss problems with materials which students are better able to point out.

3. I feel that the weakest point of the present program is its relation to the mathematics laboratory. Lab materials are not at present geared to course material. While I agree with the staff that the written materials have priority, I feel that the math lab potential should be realized. The lab space and personnel se ems quite adequate; what is needed are experiments which relate to the subject matter being taught. Math labs have become extremely popular throughout the country and there is a wealth of material on which to draw.

Again, let me state that the progress that I have observed is excellent. I was especially pleased by the spirit of cooperation that exists not only in the mathematics department but throughout the university. This is an essential element in the success of any experimental program. I fully expect this program to achieve its goals.

Appendix IX--Schedule of Visit and Report from Dr. Raymond Coughlin, Consultant to Mathematics Department

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

Schedule for Consultation

with

Dr. Raymond Coughlin
Department of Mathematics
Temple University
Philadelphia, Pennsylvania

Thursday, April 19, 1979

9:00	Mr. L. W. Jones	Mercedes Hall
9:30	Dr. Norman C. Francis with Physics consultant Dr. Jack Lochhead	President's Office
10:00	Mr. Jones Dr. Esther Fontova Mr. William Bany	Mercedes Hall
11:00	Mr. Winston Brown	APLC
12:00	LUNCH	
1:00	Joint staff meeting Mathematics & Physics and Cause committee	Faculty Meeting Room
2:00	Mr. Jones and other Mathematics faculty	Mercedes Hall

Friday, April 20, 1979

9:00	Mr. Jones	
9:30	Sr. Miriam Francis Quinn Sr. M. Veronica Drawe	Dean's Office
10:00	Mathematics Faculty	Mercedes Hall
11:30	LUNCH	
1:00	Consultant's Report	Mercedes
3:00	APLC Dedication	APLC

Appendix IX (continued)

Consultant Report
Evaluation of the Mathematics Component of the CAUSE Project
at
Xavier University of Louisiana

Prepared by: Raymond Coughlin
Department of Mathematics
Temple University
Philadelphia, Pa.

Appendix IX (continued)

During the two day visit to Xavier University of Louisiana on April 19th and 20th I interacted with the faculty of the departments of Mathematics, Biology, Physics and Chemistry. I was asked to concern myself mainly with the calculus sequence offered by the Mathematics Department. In addition, any comments or suggestions that I could make about other aspects of the Mathematics program, especially the pre-calculus segment, would be welcome.

Before I get into the meat of this report, I find it necessary to comment on the faculty at Xavier University. I was greeted by Bill Jones on Thursday morning and my first meeting was with Dr. Norman C. Francis, President of Xavier University. Soon after I met with other members of the Mathematics faculty and then a round table discussion with most of the faculty from the four departments. I found a genuinely warm and friendly atmosphere. I found a resourceful, dedicated and mission-oriented group of teachers. The faculty works well together, they define goals, implement strategies, and use a highly developed sense of cohesiveness to insure their students get an outstanding education. I was very impressed with the President and his faculty.

Many of the recommendations that I will make will require a great deal of effort to implement. I feel confident that the faculty can do an outstanding job because they have already demonstrated their dedication to teaching and preseverence. I urge the administration of Xavier University to support their faculty in these endeavors with inducements such as released time. The long range benefits will be bountiful.

The Mathematics Department has decided to implement a novel approach to the teaching of calculus. Of approximately 125 students taking the first semester, only about 25 are physical science majors who are required to take the second and third semesters. The remaining 100 students are required to take only the

one semester course. Xavier has decided to use a survey of calculus text designed for a one-semester course, in the first semester. They will then use a classical calculus text, designed for a three-semester course, in the remaining two semesters.

I feel this approach is not only pedagogically sound,but, because of Xavier's clientele, it offers the bulk of their students a great advantage over the traditional two tract system where the students would be separated at the outset. Let me refer to those taking a one semester course as the non-science majors, even though I recognize that some of them major in the natural sciences. These students gain little by taking a one semester course if the text used is a classical one. On the other hand, the survey of calculus texts are specifically designed to meet their needs. Thus the non-science majors benefit from this approach. The only possible disadvantage, then, would be for the science majors in the first semester in which, it may be argued, they get a less rigorous treatment of calculus. While this may ring somewhat true, it is far outweighed by the fact that the science major will get an overall view of calculus in the first semester. There is plenty of time in the next two semesters to initiate the student to the more rigorous aspects of the subject. I strongly feel that the survey of calculus in the first semester will help even the prospective mathematics major understand what calculus is all about, what types of problems it solves and where it fits in the total fabric of science. Rather than covering just the derivative in depth in the first semester, Xavier's students will encounter both the derivative and the integral as well as some of their applications. In the next two semesters when these topics are revisited, with their meaning and usefulness firmly intrenched, there is time enough to train the students' minds in the rigorous methodology of mathematics.

Another side of the issue centers on the type of student that Xavier educates. Often the student comes to the calculus course less prepared than his counterpart at some other universities. This is in part due to Xavier's lauditory mission of

instructing and training many inner-city young people. I feel that the survey of calculus course in the first semester of the calculus sequence will be a beneficial buffer for these less prepared students.

The key issue of this report centers on the instructional techniques used by the Mathematics Department in teaching calculus using this novel approach. I would recommend that the faculty list their short term and long term goals of the calculus sequence. By short term I mean the goals that the students can reasonably attain by the end of the sequence (both one semester and three semester goals). This exercise has been virtually completed by the faculty in their writing of the calculus handbook. I saw a rough draft of this document. I would suggest that some applications be added to the handbook as well as a more thorough description of the types of final exams that might be administered.

The long term goals are also important. I mean long term in the sense of abilities retained after a number of years. I think these differ from short term goals in that one would not expect a senior who took a one semester calculus course in the freshman year to pass the final exam three years later. What abilities do you want the student to exhibit, say, three years after the course? Once these long term goals are defined one graphically sees the difference between a survey of calculus and a classical calculus course. In short, the faculty must have concrete answers for the question "Why should a student take a one-semester survey of calculus course?". The goals for the classical course are immediate, it is the survey course goals which must be worked on.

One theme that one might center one's attention on in order to differentiate between the two types of long range goals would be: the science major must master the techniques of calculus and retain them for further course work but the non-science major would be required to understand why, how and where others utilize those techniques.

Xavier's faculty is certainly well equipped to assemble a good list of short and long range goals, but to shed further light on what I am suggesting, let me present a brief, initial description.

	Survey course (one semester)	Classical (three semesters)
short term	graph $y = x^3-x$, $y = \frac{x}{1-x^2}$ $y = e^{2x}$ ...	$y = x^3-x$, $y = (x^3-x)^{1/2}$ $y = e^{1-x^2}$,...
long term	be able to read a journal article using 1st and 2nd order differential equations	solve 1st and 2nd order differential equations
	be able to read a text in a math related field, such as econometrics which utilizes extremal techniques for functions of several variables	solve extremal problems for functions of several variables.

By their very nature, the long term goals will be vaguer in content, less concrete in presentation. The purpose for going through this exercise is to acquaint the instructors with the difference between the classical calculus course and the survey course. Once that difference is established, teaching techniques and strategies can be discussed and agreed upon. I think this is necessary because this will be a new course for most of Xavier's professors. In order to coordinate the many sections that will be taught, each instructor must have a clear idea of the goals of the course. This will insure uniformity of pedagogical approaches.

Once the goals are established, the faculty is in a good position to discuss teaching strategies. For example, the following questions must have concrete answers: How much class time will be devoted to applications, proofs, homework problems, and each section in the syllabus? How much outside reading will be assigned and/or recommended? Will a term paper on one or more of the applications be assigned? Will the science majors be urged to do extra credit? Will exams be

uniform? Will the students' ability to read and comprehend articles and books in related disciplines be monitored by giving them some articles in the beginning of the semester and getting their reactions compared to their ability at the end of the semester?

I can't emphasize too much that the faculty must have a common approach to the teaching of the survey course. It is a different course than the first semester of a classical course and it must be so taught.

A related problem would be the choice of textbooks. A number of excellent survey course texts are available and the faculty have narrowed the choice to a few good ones. Meshing the first semester with the next two is a harder problem. I have considered a number of texts for the second and third semesters and, while a number of them would be adequate, I am convinced that Swokowski and Riddle are superior, with the nod to Swokowski. If Swokowski is used, I suggest the following syllabus:

Second semester (Math 207): Chapters 9,10,14,15,16,18.

Third semester (Math 208): Chapters 7,11,12,13,17,19.

Chapter 19 could be covered in the second semester. Also in the second semester I'd recommend that some further work on limits from Chapters 2 and 4 (Section 4-5 explicitly) be incorporated. This would provide the science major with a good introduction to the more rigorous development of calculus. This syllabus provides the student with a more than adequate background for advanced work in mathematics.

The pre-calculus courses at Xavier appear to be of high quality. I am especially impressed with the handbook. The material is sectioned into modules and learning goals are listed. A student passing out of this course is adequately prepared for calculus. I'd highly recommend that this same format be followed when developing the handbook for calculus. It did appear that this is the case. I would suggest that solutions and hints to selected exercises be included in the handbook. Also, further readings on selected applications would be a welcome

welcome addition. Sample tests with and without solutions should be included.

I found the Alternate Pathway Learning Center to be a boon for the students. I have two recommendations for the Center. The use of the tapes and cassettes should be demonstrated in the regular classroom so the student is more comfortable with them when in the Center. This would have the added benefit of familiarizing the faculty with them. The CAI equipment on hand could be better utilized. This would require a great deal of time and effort from one or more faculty members, but the reward would be great. There is a good deal of material available in this area.

One of the most impressive parts of my visit to Xavier was seeing the beautiful rapport the faculty has with the students. A visitor can't help noticing the friendly greetings,the jibes and kidding as well as the serious interactions that constantly takes place. Given Xavier's mission, I believe this warm atmosphere is an outstanding pedagogical aid. I'd suggest that the faculty pursue avenues that might foster this close relationship outside the classroom. For example, at Temple University we formed a problem solving group with faculty and students that meets one a week. We have a good, easy, recreational time solving interesting problems. You'll find we solve many of the Monthly problems and the students get a kick seeing our group's name in print each month. I believe Xavier could start the same type of group. You could meet once a week solving problems of your own choosing; from the Monthly, the Math Teacher, or from any number of good books. Not only Mathematics majors will be interested, but Physics, Chemistry and Biology people will get involved. You might even consider some friendly competition among the four departments. (I myself would even pay to see Bill Jones and J.W. square off on a math contest! Sparks would fly!) We have even carried this idea to the area high schools. I'm sure with Xavier's dedication and resources, especially the Alternate Pathway Learning Center, such an endeavor would be successful.

I left Xavier with a very positive attitude toward the institution. From the President to the faculty I found boundless energy and commitment. I hope I have been of some service and have provided some help.

Appendix X--Schedule & Report of Dr. Pickett, Consultant to Physics Department

Schedule of Activities
Dr. Charles Pickett
Consultant to Physics Dept., CAUSE Grant

Tuesday, April 11, 1978

Time	Activity	Place
8:30 a.m.	Meet with Dr. Vincent	Admin. Bldg Room 220A
8:45 a.m.	Tour of Physics	Admin. Bldg. Room 217
9:00 a.m.	Meet with Dr. Ioup	Admin. Bldg. Room 220A
9:30 a.m.	Meet with Sr. M. Veronica and Sr. M. Francis, Deans	Dean's Office
10:30 a.m.	Meet with Mr. Bivens	Admin. Bldg. Room 217
11:00 a.m.	Dept. Meeting	Admin. Bldg. Room 217
12:00 Noon	Physics 202 Class	Admin. Bldg. Room 304
1:00 p.m.	Lunch	
2:00 p.m.	Meet with Dr. Guitart	Admin. Bldg. Room 217A
2:30 p.m.	Review Materials	Admin. Bldg. Room 217

Wednesday, April 12, 1978

Time	Activity	Place
9:00 a.m.	Review Materials	Admin. Bldg. Room 217
11:00 a.m.	Written Report	Admin. Bldg. Room 217
12:00 Noon	Physics 202 Class	Admin. Bldg. Room 304
1:00 p.m.	Lunch	
2:00 p.m.	Meet with Dr. N. C. Francis, University President	Admin. Bldg. President's Office
2:30 p.m.	Written Report	Admin. Bldg. Room 217

Mississippi Valley State University

DEPARTMENT OF CHEMISTRY AND PHYSICS

ITTA BENA, MISSISSIPPI 38941

April 17, 1978

Dr. Harold A. Vincent
Associate Professor
Physics/Pre-Engineering Department
Xavier University of Louisiana
New Orleans, Louisiana 70125

Dear Dr. Vincent:

Thank you for the invitation to be a consultant for the physics phase of your NSF Cause project at Xavier University. The visit to your campus was both enjoyable and informative. I especially enjoyed Dr. Parrot's presentation, "The Physics of Musical Scales." I am especially impressed with the pre-med program at Xavier and feel that I have attained some ideas that will help us to strengthen our pre-med program at Mississippi Valley State University.

I can appreciate the long hours that you have given in the preparation of the physics phase of the NSF CAUSE project especially as relates to the course objectives. Ironically, I am in the process of writing performance objectives for the introductory physics course here at "the Valley" and I feel that using your list as a reference will make my work somewhat less time consuming.

The format for my evaluation is as follows:

(1) Activities:

Tells you specifically the things that I did to collect the data for my evaluation.

(2) Persons consulted:

A listing by name and positions of persons whom I interviewed in the formulation of my evaluation.

(3) Evaluation and suggestions:

A separate evaluation of each part of the physics phase of the CAUSE project with suggestions where appropriate.

AN EQUAL OPPORTUNITY EMPLOYER

Appendix X (continued)

(4) Overall evaluation:

An overall evaluation as relates to the success or failure of the program based upon the individual evaluations of the separate parts.

ACTIVITIES

1. Read the overall CAUSE Proposal.
2. Throughly read the material for the physics phase of the CAUSE Proposal.
3. Visited two different in-session physics laboratories.
4. Visited four different in-session physics lectures and remained for the whole hour in two of them.
5. Attended Physics Departmental Meeting.
6. Interviewed all faculty members and administrators involved in the physics phase of the NSF CAUSE project.

(2) Persons consulted:

1. Dr. Julliette Ioup
   Associate Professor
   Dept. of Physics/PRE-ENG.
2. Dr. Augusgin C. Guitart
   Professor
   Dept. of Physics/Pre-Eng.
3. Mr. Bill Bivens
   Instructor
   Dept. of Physics/Pre-Eng.
4. Dr. Harold A. Vincent
   Associate Professor
   Dept. of Physics/Pre-Eng.
5. Sr. M. Veronica, S.B.S.
   University Dean
6. Sr. Miriam Francis, S.B.S.
   Dean of the College of
   Arts and Sciences
7. Dr. J. W. Carmichael
   Director of the Xavier
   CAUSE Project
8. Dr. Norman C. Francis
   President

Appendix X (continued)

(3) Evaluation and suggestions:

Administration

I am very pleased to inform you that all of the administrators that I interviewed were cognizant relative to the specifics of the CAUSE project. This trend was epitomized in my conversation with Dr. Norman Francis, your President. I was especially impressed not only with his general knowledge of the CAUSE project but with the specific knowledge of the general objectives of the physics phase of the project. Needless to say no program can be very successful without the support of the institutions administrators and I can say without reservation that you have the support of the administrators at Xavier University.

Faculty

It was both surprising and refreshing to see an institution the size of Xavier University with three full-time and one part-time physicists on the faculty. In talking with these faculty members, I found that each one was aware of the specific objectives of and in total support of the physics phase of the CAUSE proposal. In examing the credentials of your physics faculty members, I found that you have 75% Ph.D's. I was fortunate enough to spend some time in an actual classroom setting with all of your physics faculty members except one and again I was impressed. It is the opinion of the evaluator that your physics faculty is both willing and capable of implementing the physics phase of your CAUSE project.

Course Content

It is clear to this evaluator that you have given special attention to the fact that you are unlikely to cover all topics covered in the textbook within a two semester period. I do feel that you have made good choices in reordering the sequence of topics covered in your present textbook. I do suggest that you formulate a flexible time frame to coincide with your topic sequence.

Test Bank

I found several typographical errors on some of the test and I made note of these. I noticed two questions that I thought might have been misleading for students and I indicated that they should be rewarded. Other than these minor flaws I feel that the test bank is quite suitable as an instrument to both test for your stated objectives and serve as a tool of self evaluation for students. Unfortunately, I am in a dilemma relative to how an answer sheet should be handled. In my conversation with you, we discussed several possibilities all of which had disadvantages. I think that this will have to be a judgement call by you and hope for the best. . . good luck.

Course Objectives

EXCELLENT

Appendix X (continued)

Sample Problem

The problems that you have formulated are in keeping with your objectives and are representative of an introductory level physics course. You have made the correct choice in writing your problems and questions and then showing the solutions in detail. This of course allows you to change your textbook and still have a useful set of sample problems for your students.

Laboratory

The experiments that you have chosen are adequate in both number and content. In my conversation with you, I noted that the format for the experiments were somewhat inconsistent. You informed me that the inconsistency in format resulted from each physics faculty member being responsible for the formulation of some of the experiments. You also showed me the general laboratory instruction sheet that should alleviate any confusion on the part of the student. I do feel that this instruction sheet is more than adequate and I feel that you made the right choice in letting each faculty member have input in the formulation of the laboratory activities. I do however suggest that you name those experiments that were not named and rework the formats for consistency.

Overall evaluation

It is obvious that you have spent many hours in the preparation of the materials and activities for the physics phase of your NSF CAUSE project. If you are as successful in the implementation of the program as you have been in the preparation of the program the hours that you have spent will not have been in vain. To successfully implement your program, you must have the continued support of both your administration and faculty, and as I indicated above they are certainly knowledgeable of your program and appear to be in full support of your efforts.

Sincerely,

Charles Pickett

Charles A. Pickett, Ph.D.
Chairman
Department of Chemistry and Physics

CAP/frb

Appendix XI--Schedule of Visit and Report by Dr. Jack Lochhead,
Consultant for Physics Department

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411
College of Arts and Sciences

CONSULTANT SCHEDULE
for
DR. JACK LOCHHEAD

THURSDAY, APRIL 19, 1979

8:30 a.m.	H. A. Vincent	Rm. 220 A
9:30 a.m.	Dr. N. C. Francis	President's Office
10:00 a.m.	Sr. M. Veronica Drawe and Sr. Miriam Francis Quinn	Dean's Office
11:00 a.m.	Physics Seminar	Rm. 217
12 Noon	Lunch	
1:00 p.m.	KENAN and CAUSE Committees and Math Consultant	Rm. 201 of Pharmacy Building
2:00 p.m.	Dr. JW Carmichael	MSL
3:00 p.m.	Phy./Pre-Eng. Department	Rm. 217

Appendix XI (continued)

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

College of Arts and Sciences

CONSULTANT SCHEDULE
for
DR. JACK LOCHHEAD

FRIDAY, APRIL 20, 1979

8:30 a.m.	Physics-CAUSE Materials Evaluation	Rm. 220 A
10:30 a.m.	Physics-APLC Component: facilities and materials	APLC
11:30 a.m.	Lunch	
1:00 p.m.	Consultant's Report	Rm. 217
3:00 p.m.	APLC Dedication	APLC

Consultants Report on the Physics Program in the Xavier University CAUSE grant.

by Jack Lochhead

Appendix XI (continued)

May 1, 1979

On April 19 and 20 I visited Xavier University and met with three members of the Physics Department as well as most of the CAUSE staff. Professor Harold Vincent is responsible for the Physics component of the CAUSE project; this report focuses on the work that he has done. My observations are based on discussions with Professor Vincent and on the workbook he has written to accompany Physics 201-202; scheduling problems prevented me from visiting 202 classes. I did, however, attend an undergraduate seminar. I was impressed with the serious attitudes of the students and with the rapport they had with the Physics faculty.

All components of the CAUSE project have carefully reviewed the syllabus in the core courses with the goal of maximizing the interelatedness of these courses and reducing the number of non-essential topics. The 201-202 workbook reflects this emphasis on basics essential to later course work. Nonetheless there are probably a few unnecessary items in the course and I would recommend continued pruning so that more time is available for the toughest topics. Two areas where it may be possible to reduce the coverage are the Mechanical Properties of Matter and rotational motion. I am skeptical of the ability of most first year students to absorb much in those areas- carefull coordination with the chemistry course may allow for additional pruning in Kinetic Theory and Thermodynamics.

The course exams include both short answer or multiple choice questions and longer questions requiring complex calculations. I was particularly impressed by the quality of the short qualitative questions. Many of these require a sophisticated understanding of physics and stress areas where students frequently have serious difficulty. I encourage the continuing emphasis on such questions because they help <u>both</u> faculty and students recognize how much physics is really being learned in contrast to the rote learning of rules.

Appendix XI (continued)

Questions of this type[1] should also be included among the sample problems which currently contain only calculational problems.

The 201-202 laboratories are good traditional exercises. They have a distinct advantage over many more modern laboratories in that they use simple equipment which the students can readily understand. One laboratory- the simple pendulum- uses the learning cycle format emphasized in Xavier's SOAR program. I would like to see more of the laboratories redesigned to fit this format. However, the change should be done gradually; it usually takes several attempts to tune a learning cycle lab to fit the level of student.

The workbook contains a few typographical errors and section headings are sometimes left out. It would be useful to have the booklet reviewed by a competent secretary or student who could make small format corrections.

The goal of the CAUSE program is ambitious and important. The physics component has made significant progress but maintaining that development will require continuing interaction with faculty in other departments, especially those in math and chemistry. Interdepartmental coordination of this kind is very rare and Xavier is fortunate to have accomplished it.

[1] Professor Robert Bauman, Dept. of Physics, University of Alabama, Birmingham refers to such problems as "asking very difficult questions about very easy material". It would probably be very profitable for the Xavier physics program to establish contact with Prof. Bauman's group.

Appendix XII--A Prescription for the Common Final Examination for Mathematics 103

COMMON FINAL EXAM FOR (PRECALCULUS) MATHEMATICS 103

A prescription for a final exam was arrived at in conference with all five instructors of precalculus during the Fall 1978. This prescription consisted of listing by module objective of the content to be tested on the final exam. The prescription included by each objective the point value of each of the problems to be included. The total point value amounted to 105 points. It was then decided that a subcommittee (Dr. Esther Fontova and Dr. B. William Irlbeck) would be responsible for the actual writing of two forms of a test following the prescription.

Consequently, these forms (see attachment) were administered to all 6 classes with approximately one half of each class taking form A and the other half taking form B. The results for each form were compared as a check for equivalency. These showed that the forms were approximately equivalent. Further data per instructor was also collected. This data is summarized on the next page. It should be noted that the distribution of scores according to the usual grade intervals 90-100, 80-90, 70-80 etc. showed that the scores were not normally distributed.

PRESCRIPTION FOR PRECALCULUS EXAM

Objective		Point Value		Objective		Point Value	
I.4	--	3 pts.	12	IV.8	--	4 pts.	16
I.8	--	3 pts.		IV.13	--	6 pts.	
I.9	--	3 pts.		IV.14	--	4 pts.	
I.10	--	3 pts.		IV.16	--	2 pts.	
II.12	--	4 pts.	16	V.2	--	2 pts	16
II.8	--	4 pts.		V.8	--	2 pts.	
II.11	--	4 pts.		V.9	--	6 pts.	
II.13	--	4 pts.		V.10	--	6 pts.	
III.4	--	8 pts.	22	VI.6	--	4 pts	9
III.5	--	1 pt.		VI.7	--	3 pts.	
III.8	--	3 pts.		VI.10	--	2 pts.	
III.9	-	4 pts.		VII.7	--	4 pts.	14
III.10	--	1 pt.		VII.8	--	5 pts.	
III.12	--	2 pts.		VII.9	--	5 pts.	
III.14	--	3 pts.					

Total 105 pts

Appendix XIII-- PRECALCULUS COMMON FINAL EXAM

DATA FROM DECEMBER 1978

	FORM A		FORM B		COMBINED		
INSTRUCTOR	N	$\bar{X}$	N	$\bar{X}$	N	μ	σ
BROWN	17	58.4	11	58.1	28	58.3	17.0
FONTOVA	24	60.3	23	64.5	47	62.3	21.9
IRLBECK	14	64.5	14	50.1	28	57.3	21.8
JONES	19	63.6	16	65.1	35	64.3	18.1
KLEINHAUS	14	52.9	12	58.3	26	55.4	19.2
COMBINED	88	60.1	76	60.1	164	60.1	21.1

CORRELATION BETWEEN EXAM SCORE AND COURSE GRADE = .95

DISTRIBUTION OF SCORES ON FINAL EXAM

	100-90	89-80	79-70	69-60	59-50	49-40	39-30	20-0
FORM A	8%	14.8%	10.2%	17%	14.8%	17%	15.9%	2.3%
FORM B	10.5%	18.4%	6.6%	11.8%	17.1%	17.1%	10.5%	7.9%
COMBINED	9%	16.5%	8.5%	14.6%	15.9%	17%	13.4%	5%

DISTRIBUTION OF COURSE GRADES (for those students who took final exam)

INSTRUCTOR	A	B	C	D	F
BROWN	17.9%	21.4%	21.4%	28.6%	10.7%
FONTOVA	21.3%	19.1%	25.5%	23.4%	10.6%
IRLBECK	10.7%	10.7%	21.4%	42.9%	14.3%
JONES	25.7%	20.0%	22.9%	25.7%	5.7%
KLEINHAUS	11.5%	15.4%	23.1%	38.5%	11.5%
COMBINED	18.3%	17.7%	23.8%	29.9%	10.4%

FINAL PROGRAM

NSTA 27th Annual Convention

ATLANTA, GEORGIA

March 23-26, 1979

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Friday, March 23

1 PM-2 PM

49. LOCI Project Symposium—Review of Selected NSF LOCI Projects.
Atlanta Hilton Hotel
Thomas Jefferson Room

Presider: Martha T. Hatcher, Professor of Biology, Gainesville Junior College, Georgia.

50. LOCI Project Symposium—Review of Selected NSF LOCI Projects.
Atlanta Hilton Hotel
Council Room

Presider: Dorothy Brock, Associate Professor of Biology, Northern Georgia College, Dehlonega.

2:10 PM-3:10 PM

51. LOCI Project Symposium—Review of Selected NSF LOCI Projects.
Atlanta Hilton Hotel
Thomas Jefferson Room

Presider: Rebecca A. Halyard, Associate Professor, Biology, Clayton Junior College, Atlanta, Georgia.

52. LOCI Project Symposium—Review of Selected NSF LOCI Projects.
Atlanta Hilton Hotel
Council Room

Presider: Dorothy Brock, Associate Professor of Biology, Northern Georgia College, Dehlonega.

1 PM-2 PM

53. CAUSE Project Symposium—Review of Selected NSF CAUSE Projects.
Atlanta Hilton Hotel
John Adams Room

Presider: Harry Prince Allen, Associate Professor of Mathematics, Ohio State University, Columbus.

Highlights of the Science Learning Center at the University of Texas at Arlington.

Presenter: Ann Benham, Associate Director, Science Learning Center, University of Texas, Arlington.

Multi-Pathway Learning.

Presenter: Jacqueline T. Hunter, Instructor, College of Arts and Sciences, Xavier University, New Orleans, Louisiana.

Improvement of Science Instruction and Development of Evaluation Procedures.

Presenter: Philip John Arnholt, Assistant Professor, Concordia College, Milwaukee, Wisconsin.

Complementary Concept Modules for Mathematics, Chemistry, Biology and Physics.

Presenter: Eldon L. Miller, Chairman, Department of Mathematics, University of Mississippi, University.

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Appendix XIV--Program from NSTA Meeting indicating Presentation by Ms. Hunter

Appendix XV--Portion of Program from CAUSE Dissemination Workshop indicating presentation by Dr. Carmichael concerning XU's CAUSE Grant

COMPREHENSIVE ASSISTANCE TO SCIENCE EDUCATION (CAUSE)

INFORMATION EXCHANGE SEMINAR

(CIES)

- PROGRAM -

(All sessions and meals will be in the Jane S. McKimmon Center)

Monday, August 6, 1979

11:00 am - 12 Noon	CIES Registration
12 Noon - 1:00 pm	Lunch
1:00 pm - 1:10 pm	Welcome and Seminar Administrative Procedures - Denis Jackson, Project Director N.C. State University
1:10 pm - 1:15 pm	Introduction of NSF staff - Richard W. West, Program Director CAUSE
1:15 pm - 1:20 pm	Schedule of Events - Lawrence H. Oliver, Program Manager CAUSE
1:20 pm - 1:40 pm	Historical Overview of CAUSE and Purpose of Seminar - Richard W. West
1:40 pm - 1:55 pm	Science Education at NSF - Marjorie Gardner, Division Director Science Education Resources Improvement (SERI)
1:55 pm - 2:00 pm	Seminar Evaluation - Judith B. Erickson, SERI
2:00 pm - 3:00 pm	

Session 2-1 Chairperson: Lawrence H. Oliver
Presenter: Avery J. Dennis, Sandhills Community College

"Improvement of Instructional Delivery via Establishment of an Individualized Instructional Laboratory" (Area 3)

Appendix XV (continued)

Session 4-1 Chairperson: Richard W. West
Presenter: J.W. Carmichael, Jr., Xavier Universi at New Orleans

"Development of an Alternate Pathway Learning Center" (Area 4)

3:00 pm - 3:30 pm Coffee/Soft Drinks

3:30 pm - 4:30 pm

Session 2-2 Chairperson: Richard W. West
Presenter: Curtis Miles, Piedmont Technical College

"Development of an Interdiscipline Electronics/Math Problem Solving Curriculum" (Area 3)

4-year and Ph.D. Institutions - Proposal Reading File (Area 5)

4:30 pm - 5:30 pm

2-year Institutions - Proposal Reading File (Area 5)

Session 4-2 Chairperson: Marjorie Gardner
Presenter: James L. Koevenig, Florida Technical University

"Use of Video Cassettes and Minitexts to teach Remedial Skills and Concepts in the Biological Sciences" (Area 4)

6:30 pm - 7:30 pm Dinner (Area 2C)

xxxx

Appendix XVI--Statistics for the Use of the APLC since its opening.

XAVIER UNIVERSITY OF LOUISIANA

Inter-Office Memo

To JW Carmichael, Professor of Chemistry

From Leslie R. Morris, Director of the Library LRM

Date December 18, 1980

Subject APLC Attendance

Month	1979/80		1980/1	1978/79*
July	3549		3124	
August	3055		2405	
September	14997		15979	
October	19221		15979	
November	16198		19700	
December	11293	SUB TOTAL	11947	
January	5905			1292
February	13453			10210
March	15647			13704
April	12929			11691
May	10282			5570
June	5224			4386
TOTAL	131753	TOTAL	53155	46853

*Added by JWC
from previous memo.

Tentative Program

Appendix XVII--Program for SREB-sponsored SREB Workshop in New Orleans
SCIENCE INSTRUCTION SEMINAR

Sunday	6	p.m.	Reception and Registration	
	7:30	p.m.	Overview of entire program	James M. Godard, SREB
	8	p.m.	Presentation: Development and Operation of Science Learning Centers	Dr. Howard Carter Tuskegee Institute
			Commentators: Dr. Johnny Gills Jackson State University	
			Sister Grace Mary Flickinger Xavier University	
			Discussion	
Monday	9	a.m.	Summer Programs	Dr. J. W. Carmichael Xavier University
			Outreach to High Schools	_____
			Discussion and Coffee Break	
			Computer-Assisted Instruction	Dr. William G. Hedgpeth Benedict College
			Discussion	
	1:30	p.m.	Demonstrations (Xavier Campus)	
			Learning Centers, Tutorial Services	Sr. Grace Mary
			Computer-Assisted Instruction	Dr. Brown/Sr. Eileen + Gills + Hedgpeth
			Laboratory Teaching Procedures	Sr. Joanna
			High School Programs	
Tuesday	8:30	a.m.	The Literature of Science	Ancilla Coleman Jackson State University
			Science Instrumentation	Robert A. Izydore N.C. Central University
	Noon		Adjournment	

Appendix XVIII--Schedule & Report for Overall, Final Evaluation

Xavier University of Louisiana

NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

Schedule for

Dr. Bobby N. Irby

Chairman, Department of Science Education

U. of Southern Mississippi

to evaluate

CAUSE Grant SER77-06227

Monday, April 21

9:00- 9:30	JW Carmichael	University Guest House
9:30-10:00	Sr. Veronica Drawe, University Dean	Admin. 207
10:00-11:00	JW Carmichael	Guest House
11:00-12:00	CAUSE Committee Jacqueline Hunter, Biology Sr. Grace Mary, Biology Bill Jones, Mathematics Harold Vincent, Physics Sr. Joanne Bauer, Chemistry JW Carmichael, Chemistry Bill Irlbeck, Math (cannot attend)	Guest House
12:00- 1:00	Lunch	Faculty Dining Room
1:00- 2:00	Chemistry: Sr. Joanne, Barbara Wells, & JWC	Guest House
2:00- 3:00	Physics: Harold Vincent	Admin. 220A
3:00- 4:00	Math: Bill Jones & Bill Irlbeck	Mercedes

Tuesday, April 22

9:00-10:00	Biology: Sr. Grace Mary & Jacqueline Hunter	Admin. 320
10:00-11:00	Visit APLC & talk with students	APLC
11:00-12:00	JW Carmichael	MSL
12:00- 1:00	Revisit as needed & write report	

University of Southern Mississippi
Southern Station, Box 5087
Hattiesburg, Mississippi 39401

Department of Science Education

May 7, 1980

Dr. J. W. Carmichael
Director, CAUSE Project
Xavier University of La.
New Orleans, LA 70125

Dear Dr. Carmichael,

Please find attached the evaluation report on Xavier University's Cause Project.

If you have any questions about this report, please do not hesitate to call on me.

Sincerely,

Bobby N. Irby
Chairman

BNI:ke

Appendix XVIII (continued)

Report of Site Visit
To Xavier University
Of Louisiana CAUSE Project

Prepared By: Bobby N. Irby, Chairman
Department of Science Education
University of Southern Mississippi
Hattiesburg, MS 39401

I. Advance Preparation

A. Advance Preparation

Prior to my visit to Xavier University of Louisiana, Dr. J. W. Carmichael, Jr., Project Director, sent me copies of the original CAUSE proposal and subsequent reports on the Mathematics and Science Project. The project was for the development of a multi-departmental improvement program for the entry-level courses in science and mathematics for science majors. The documents were studied to provide sufficient background about the work proposed, to maximize the usefulness of a 2-day on-site visit.

Dr. Carmichael arranged an itenerary as follows:

Monday, April 21

9:00 - 9:30	J. W. Carmichael	University Guest House
9:30 -10:00	Sr. Veronica Drawe University Dean	Administration 207
10:00 -11:00	J. W. Carmichael	Guest House
11:00 -12:00	CAUSE Committee Jacqueline Hunter, Biology Sr. Grace Mary, Biology Bill Jones, Mathematics Harold Vincent, Physics Sr. Joanne Bauer, Chemistry J. W. Carmichael, Chemistry Bill Irlbeck, Math	Guest House
12:00 - 1:00	Lunch	Faculty Dining Room
1:00 - 2:00	Chemistry: Sr. Joanne Baeur Barbara Wells, J. W. Carmichael Sr. Carla, Chairman	Guest House

Monday, April 21 (Continued)

2:00 - 3:00	Physics: Harold Vincent	Admin. 220A
3:00 - 4:00	Math: Bill Jones & Bill Irlbeck	Mercedes

Tuesday, April 22

9:00 - 10:00	Biology: Sr. Grace Mary & Jacqueline Hunter	Admin. 320
10:00 - 11:00	Visit APLC & talk with students	APLC
11:00 - 12:00	J. W. Carmichael	MSL
12:00 - 1:00	Revisit as Needed & write report	

B. People Interviewed

The following people were interviewed during my site visit:

CAUSE Committee:	Dr. J. W. Carmichael, Director Sr. Joanne Bauer Ms. Jacqueline Hunter Sr. Grace Mary Flickinger Mr. Bill Jones Dr. Harold Vincent
Mathematics:	Mr. Bill Jones Dr. Bill Irlbeck Sr. Rosemarie Kleinhaus, Chairperson
Chemistry:	J. W. Carmichael Sr. Joanne Bauer Sr. Mary Carla Mahmstrom, Chairperson
Physics:	Dr. Harold Vincent, Chairperson
Administrators:	Sr. Veronica Drawe, University Dean
Students:	Unidentified

Appendix XVIII (continued)

II. On-Site Interpretation

A. Project Institutionalization

Accomplishment of total institutionalization of the project is among the very significant accomplishments of the project leadership. The eight courses for the science and mathematics entry-level preparation of science majors which were developed as one of the major objectives of the CAUSE project, have become an official part of the Xavier University's Science and Mathematics Curriculum.

Additional evidence of institutionalization of the project include (A) the strong support by the administration, (B) the current and projected role of the Alternate Pathway Learning Center (APLC), (C) classroom and laboratory facilities and probably the most important, (D) the faculty interest and commitment to the program. These courses, (as all courses at Xavier University), are taught exclusively by regular faculty members, including laboratory. Teaching assistants are not utilized as instructors. Taken together, these represent a very important commitment of physical and human resources to the Xavier University's academic program.

Additionally, during the CAUSE project, Chemistry developed and implemented a second semester Piagetian-based laboratory in general chemistry for its entry-level majors and established the mechanism for evaluating their majors' progress throughout their degree programs.

B. Facilities

Facilities are somewhat old and in need of renovation. Also, they are possibly in need of expansion, but at the present, these are put to maximum use and are considered adequate (possibly with the exception of chemistry). Basic equipment for the teaching of entry-level courses addressed by the CAUSE project seems to be sufficient. However, no detailed evaluation of the facilities and equipment needs was undertaken. Conclusions were based on input from faculty.

II. On-Site Interpretation (Continued)

Teaching Assistants, (undergraduate or graduate) are not available to assist the faculty with the day-to-day chores. Faculty members lecture, prepare all laboratory set-ups, grade papers, develop evaluation instruments, etc. This contact manifests itself in superior instruction. Student benefits seem to be worth the extensive effort of the faculty. However, it would seem cost effective to utilize senior science majors to assist with laboratory preparations and free the faculty for other constructive activities. Surely the faculty has been involved in many extracurricular activities that effectively promote Xavier University and CAUSE.

C. Course Structure

The entry-level courses of all four departments (two courses per department) consist of a commercial textbook, laboratory manual, and student workbook. The latter two items were developed as part of the CAUSE Project. Additionally, each department has begun to administer common final examinations in all sections of a given course. Chemistry chose to use the American Chemical Society's Cooperative Examination as the final in the second semester. Mathematics and Physics were developing second semester final examinations of similar specifications.

Handbook. The handbook varies slightly among departments but basically it contains content objectives, sample problems, tests, sample calculations and solutions to problems, audiovisual materials, and references to alternate pathways for learning. The handbooks seem to be well received by the students. The brightly colored covers have served as a symbol of the CAUSE program on campus, influencing the development of handbooks by other departments.

Notable changes were made by Biology and Mathematics in their entry-level courses. Biology developed two semesters of general biology to replace a one semester each of general biology and zoology. Mathematics modified pre-calculus

II. On-Site Interpretation (Continued)

(college algebra and trigonometry) to increase emphasis on practical skills, and developed a survey of calculus to replace Calculus I, designed to serve as either a terminal course or the first semester of a traditional three-semester sequence. The results of the changes are good. The faculty and students expressed support for the new programs in biology and mathematics.

Chemistry's innovative entry-level chemistry program and its SOAR program (pre-entry level summer program for high school seniors) seem to have served as the CAUSE model for other departments to follow in the development of their entry-level courses.

D. Learning Center

The Alternate Pathway Learning Center (APLC) occupies 4,000 square feet of space on a ground floor wing of the University Library. Students can receive tutoring, view displays and demonstrations, use audiovisual materials and models, and employ calculators and computer assisted instruction. The APLC floor area is divided equally among the four content areas. Tutors are scheduled throughout the day. The APLC is open to the students on the same schedule as the library.

Students do not sign in or out and no attempt is made to check on the use of the center by individual students. However, count is recorded by turn-stile, which indicated 14,970 counts for Sept. 1979 and 10,000 plus for each month thereafter through March 1980. Some students utilize the facility more than others, but a remarkable indicator of its popularity is that considering an enrollment of 587 students, the average student use of the APLC was 17 times per month.

E. Project Staff

The CAUSE Project at Xavier was a direct outgrowth of extensive pre-planning and needs assessment at the University on the part of the faculty within the Departments of Biology, Chemistry, Physics, and Mathematics. The CAUSE

II. On-Site Interpretation (Continued)

project was implemented by a committee, which was expanded from the original representation of five to twelve in an effort to ensure that development was truly departmental. This effort seems to have been very successful. It is note worthy that the chairpersons of each of the departments involved in CAUSE were active participants in it's development. These included Sr. Gracy Mary Flickinger (Biology Chairperson), Sr. Mary Carla Mahmstrom, (Chemistry Chairperson); Dr. Harold Vincent, (Physics Chairperson); and Sr. Rosemarie Kleinhaus (Mathematics Chairperson). Their enthusiastic support was a definite contributor to the success of the project and added assurance that the program would continue as the entry-level science and mathematics courses for science majors.

F. Administrators

Sr. Veronica Drawe, University Dean and chemist by training (Ph.D.), felt that the most important area of improvement resulting from CAUSE was (1) increased cooperation and willingness among the science faculty to discuss new and innovative ideas for the improvement of educational opportunities of the entry-level science majors at Xavier University, and (2) increased student performance on standardized tests, coupled with increased student interest in the sciences as indicated by increased enrollment in the sciences.

Further, Sr. Veronica felt that the CAUSE program will continue as Xavier University's Science Program for science majors. However, as she indicated, Xavier University's faculty is cognizant of the need to continue to evaluate all phases of the educational program and make any additional changes needed for future improvements. Thus, the CAUSE program will continue to be modified as needed in the future, and probably will be expanded to include other content areas as well as additional levels of study in the sciences.

II. On-Site Interpretation (Continued)

The administrative leadership and support of the faculty is very strong and admirable.

III. Evaluation and Conclusion

A. Faculty

Faculty should be encouraged to maintain the high degree of cooperation which characterized the project. This has resulted in strong articulation of the course sequences in the four content areas. Moreover, it has been a major cause of the realization of a uniform and common philosophy throughout the eight courses.

B. Research

The faculty should be encouraged to become involved in research concerning the impact on students of the science majors program and/or of specific courses, laboratory activities, alternate pathway of learning, etc. Research of this type will develop continued faculty interest in the program and will result in continued faculty professional growth.

Analysis should be made of the status of incoming students' capabilities in basic process and reasoning skills. A correlation between these skills and the effectiveness of the Piagetian-based laboratory activities could be established.

C. Project Objectives

In general the most important achievements of CAUSE were (1) Standardization of entry-level mathematics and science courses for science majors and (2) the development of a commonality of purpose among the science and mathematics faculty. These achievements resulted in the attainment of the specific objectives to (1) improve performance in and (2) reduce attrition from the entry-level science majors courses in biology, chemistry, physics, and mathematics.

III. Evaluation and Conclusion (Continued)

1. Biology

Students increased an average of 27 percentile points on points on the CLEP General Biology exam. Students completing year sequence (123 and 124) increase from 49% to 54% from 1977-78 (pre-course) to 1978-79 (course). Students completing BIO 123 spring semester increased from 28% in 1978 to 51% in 1979. This is most significant because spring sections have higher percentages of of students with known academic deficiencies and correspondingly lower probability for success. The attempt to increase performance and reduce attrition in the biology sequence appears to have made excellent progress.

2. Chemistry

Students increased an average of 20 percentile points on the ACS exam in general chemistry. Students completing Chemistry 101 increased from 60% before CAUSE (1976-77) to 68% for the first year of CAUSE (1977-78) and to 79% in 1978-79. Students completing Chemistry 102 increased from 77% before CAUSE to 87% in 1978-79. Students completing the two semester sequence increased from 45% in 1976-77 (before CAUSE) to 56% in 1978-79. The attempt to increase performance and reduce attrition in the chemistry sequence has made tremendous progress.

3. Mathematics

Students completing Math 103 increased from 36% (pre-CAUSE) to 45% in 1978 (CAUSE). Students completing Math 104 increased from 61% to 83% after CAUSE. The attempt to reduce attrition is evident. Data for student performance was not available.

4. Physics

Students completing Physics 201 increased from 59% (pre-CAUSE) to 69% (CAUSE). Students completing Physics 202 increased from 60% (pre-CAUSE) to 73% (CAUSE). Students completing the two semester sequence in Physics (201 and 202)

III. Evaluation and Conclusion (Continued)

increased from 53% to 78%. Physics has reduced attrition considerably.

D. Conclusion and Recommendations

The project set out to address four specific objectives pertaining to science and mathematics majors.

1. To reduce attrition from and increase achievement by students in entry-level courses in science and mathematics.
2. To determine the effectiveness of the mechanism chosen to accomplish #1.
3. To provide an Alternate Pathway Learning Center.
4. To document and disseminate information.

Progress toward meeting these objectives has been excellent, and where objectives are not yet fully addressed, significant mechanisms have been established that will result in advancement toward meeting them. In short the CAUSE project has been successful.

Appendix XIX--Proceedings from Conference at Which Sr. Grace Mary Made Presentation

THE PROCEEDINGS OF THE ELEVENTH ANNUAL CONFERENCE OF THE INTERNATIONAL CONGRESS FOR INDIVIDUALIZED INSTRUCTION

THE GEORGIA CENTER FOR
CONTINUING EDUCATION

THE UNIVERSITY OF GEORGIA
ATHENS, GEORGIA

NOVEMBER 7-9, 1979

VOLUME I

ISSN 0195-6590
LC

Professor Bloom is Charles H. Swift Distinguished Professor of Education, the University of Chicago. Dr. Bloom is a founding member of the International Association for the Evaluation of Educational Achievement (IEA) and a past president of the American Educational Research Association (AERA).

9:00 - 9:30 pm — Discussion with Benjamin Bloom

Friday, November 9, 1979

Business Meeting, Lower Level Auditorium

8:30 - 9:30 am — ICII Business Meeting, Mary Lynch presiding
Reports of Officers
Election of Officers
Research Paper Award
Poster Paper Award
Preview of 1980 Meeting, Dearborn, Michigan
Announcement of 1981 Meeting site

9:30 - 10:00 am — Coffee break, Lounge

Session IIIA, Room L

10:00 - 10:20 am — Zimmerman, John L.
Kansas State University
ECOLOGICAL IMPACT ASSESSMENT VIA GUIDED DESIGN

10:20 - 10:40 am — Donmoyer, Robert
The University of Georgia
INDIVIDUALIZATION AS IDEOLOGY

10:40 - 11:00 am — Carswell, Ronald V.
TSTI-Waco (Texas)
A SYSTEMS APPROACH AND LEARNING ACTIVITY PACKAGES

11:00 - 11:20 am — Dyman, Daniel J.
Southwestern Michigan College
THE DIDACTOR: A TECHNOLOGICAL AID FOR EFFECTIVE INSTRUCTION

11:20 - 11:40 am — Flickinger, Sr. Grace Mary
Xavier University of Louisiana
ALTERNATE PATHWAYS FOR LEARNING IN A MULTIDISCIPLINARY LEARNING CENTER

11:40 - 12:00 am — Behrens, John H.
University of Illinois
DESIGN CONSIDERATION FOR AUTO-TUTORIAL LIBRARY CARRELS

CANCELED

FLICKINGER, SR. GRACE MARY, S.B.S.
Xavier University of Louisiana, New Orleans, LA 70125

ALTERNATE PATHWAYS FOR LEARNING IN A MULTIDISCIPLINARY LEARNING CENTER

One of the major problems facing college-level science faculty today is how to make science-related careers more accessible to the educationally-disadvantaged without sacrificing expected performance standards. This problem is especially acute in entry-level courses. As one part of a joint effort to individualize these courses so that both the well-prepared and the educationally-disadvantaged have a reasonable chance of achieving success, the science departments at Xavier University of Louisiana (a small, predominantly black institution in New Orleans) have established a multidisciplinary learning center in which to offer a variety of "alternate pathways" for learning. This Alternate Pathway Learning Center (APLC) is shared by the departments in such a manner that each utilizes the teaching aids which are best suited for its own special needs at a particular time. The alternate pathways available in the facility include organized peer tutoring; computer-assisted instruction; individualized use of both commercial and locally-produced AV materials; individualized testing; and individualized assistance in acquiring selected test-taking and study skills. This approach, "standards with sympathy," has been extremely effective in both reducing attrition from and increasing performance in the entry-level science courses.

CADZELLA, BERNADETTE M.
East Texas State University, Commerce, Texas 75428

THE EFFECTIVENESS OF A CAI PROGRAM ON STUDY SKILLS

In order to provide study skills instruction on an individual basis to all students who want the information, a computer-assisted instructions (CAI) program was developed. This study investigated the effectiveness of the CAI "study" program on students' study behaviors and attitudes. Subjects were undergraduates enrolled in psychology classes who were randomly assigned to the experimental (had access to the CAI program) and control (had no access to the CAI program) groups. There were 88 subjects in the experimental group and 67 subjects in the control group. All subjects responded to the Survey of Study Habits and Attitudes (SSHA) three times during the semester. Measures on the SSHA were used to determine differences and changes in study habits and attitudes. Trend analyses on the seven SSHA measures showed no significant differences between the groups, significant differences among the trials and interactions. Scores on trials increased during the semester. Reverse patterns of perceptions were found on study habits with upward shifts for the experimental (CAI) group and downward shifts for the control group. Students in the experimental group reported favorably about the CAI "study" program and to the method of presentation. It was concluded that the CAI "study" program effectively presented the information on study skills and how to develop these skills.

Appendix XX--Biology's Plans for Continuing Activities after Grant

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

TO : JW Carmichael, Director of Xavier's NSF - CAUSE Grant

FROM : J. T. Hunter, Biology Representative for CAUSE

DATE : November 28, 1979

RE : Continuation of the Biology portion of the CAUSE program

When Xavier's NSF - CAUSE proposal of 1978 was written the Biology department made a commitment to implement the CAUSE program even though personnel could change and funding would be withdrawn. The Biology portion of the grant was aimed at providing a coordinated, standardized approach to the teaching of General Biology for Science Majors and General Biology Laboratory for Science Majors. In order to maintain this coordinated approach the Biology department offers the following plan.

I. Integrate new faculty

A. New faculty should meet initially with faculty already teaching General Biology, in order to allow new faculty to:

1. Obtain background information on the development of the course.
2. Become familiar with course---Workbook, text, quizzes, laboratory manual

B. Biweekly meetings throughout the semester of General Biology faculty to talk over what is happening in the various sections of the course in an effort to iron out all problems as soon as possible

II. Updating the course with input from students and faculty

A. Questionnaire at mid-semester to get some conceptions that students have about the course, whether or not they are using the supports that are built into the course (workbook, tapes, tutoring services, etc.). The results are tallied, reviewed by the General Biology faculty, feedback and clarification, if needed, are given to the students by faculty. If it seems necessary, changes may be made.

B. Biweekly meetings of the General Biology faculty allows new faculty to have input into the course by observation and discussion of things that work or don't appear to work. This provides a valuable and continuous source of input into the course and serves to allow new faculty to feel as though the course is his/her own because of the

contribution that is made.

C. Annual meetings with the faculty of the Biology Department to review the General Biology materials, re-evaluate it, make deletions and additions that seem appropriate.

D. Collect statistics at mid-semester and the end of the semester and compare them with those from previous years as a rough gauge of present performance.

III. Maintenance of the APLC

A. The Biology department will be represented by one faculty member and one student tutor on the APLC Committee.

B. Training session for all Biology tutors.

IV. Coordinator to Supervise the General Biology Course.

A coordinator will be appointed by the chairman. His/her duties are outlined on the following page.

Appendix XX (continued)

DUTIES AND RESPONSIBILITIES OF GENERAL BIOLOGY COORDINATOR

The coordinator is expected to:

1. Prepare a day-by-day outline for the semester detailing the material to be covered each class meeting and provide a copy to each instructor.

2. Meet with the other teachers individually or in groups on a regular basis to coordinate the teaching and provide a forum for discussion of the content of course, textbook, alternate pathways, etc.

3. Prepare in conjunction with the other teachers of the course a common final examination for the course.

4. Collect copies of each instructor's hour exams as well as a copy of midterm grades and final grades.

5. As soon as possible after mid-term, compute a grade distribution for each section as well as for the combined group. This grade distribution should show the percentage of students making at least a C and those making below a C. Also a student-attitude questionaire should be distributed to all sections and the results tabulated.

6. At the end of the semester, collect a copy of class roll from each section's instructor containing name, final exam score, (plus standardized CLEP test score, if a standardized test is given), and final course letter grade for each student. Each instructor is to submit class average on the final exam (plus standardized test, if any is given) and grade distribution for his or her section.

7. Calculate over all average on final exam (plus average on any standardized test given) and overall grade distribution. This data is to be recorded on the coordinator report form (see appendix) and placed in the departmental files. This information to be recorded on the department's master sheet in the departmental file.

8. Order binders for workbooks and laboratory manuals (should be done by spring for the following year).

9. Make corrections in the laboratory manual and the workbook.

10. Get workbooks and laboratory manual to the printers and to the bookstore (send to printers by the end of the spring semester).

11. Put the answers to the workbook questions in the APLC.

12. Update the list of alternate pathways as new materials come in.

Appendix XX (continued)

Appendices to be attached to this form:

1. Copy of course schedule given to each student.
2. Copy of common final examination. (See Jackie Hunter)
3. Results of mid-term student attitude questionaire.
4. Grade distribution report.
5. Master copy.

Appendix 1

Appendix XX (continued)

Course: Basic Principles of Biology
Biology 124

Classes: 3 hours/wk

Credit: 3 s.h.

Texts: Biological Science (second edition) by Keeton
Workbook for Basic Principles of Biology

COURSE OBJECTIVES:

This course is designed so that the student

1. will be introduced to the basic concepts which unify all biological sciences.
2. will be given experience in organizing and studying problems utilizing the scientific method.
3. will develop a respect for and appreciation of life in its various forms.
4. will become aware of the diversity found among living things. Specific behavioral objectives for each module are listed in the student workbook.

ATTENDANCE

Students are urged to be present and punctual for all classes. In the event of absence, for any reason, the student is solely responsible for the information missed.

Additional Help

Tutoring is available in the Biology section of the Alternate Pathway Learning Center (in the Library). In addition, the APLC is well equipped with A-V materials designed to assist you to understand the material presented in class. Students are urged to take advantage of the services offered in the APLC. The Biology hours are as follows:

Mon. - Thurs	8:00 a.m. - 8:00 p.m.
Fri.	8:00 a.m. - 3:00 p.m.
Sat.	9:30 a.m. - Noon

In addition, your instructor is available and willing to help you with the material.

Assignments

Students are to answer all the questions in their Workbook. The answers can be checked in the APLC.

(over)

COURSE OUTLINE

Module	DATE	
	M - W - F	T - Tr.
13.01 Mitosis	Jan. 21 - 23	Jan. 22 - 24
13.01 Meiosis	Jan. 25 - 28	Jan. 29
14.01 Mendelian Genetics	Jan. 30 - Feb. 1	Jan. 31
14.02 Classical Beyond Mendel	Feb. 4 - Feb. 6	Feb. 5
14.03 Molecular Genetics	Feb. 8 - 11 - 13	Feb. 7 - 12
Test I	Feb. 15	Feb. 14
15 Plant Development	Feb. 18 - 22	Feb. 21
15.01 Animal Development	Feb. 25 - 27	Feb. 21 - 26
16 Evolution	Feb. 29 - Mar. 3	Feb. 28
17.01 Ecosystems	Mar. 5 - 7 -10	Mar. 4 - 6
Test II	Mar. 12	Mar. 11
17.02 Populations	Mar. 14 - 17	Mar. 13
17.03 Intersp. Interactions	Mar. 19	Mar. 18
17.04 Biotic Comm.	Mar. 21 - 24 - 26	Mar. 20 - 25
18 Classification	Mar. 28	Mar. 27
19 Viruses and Monera	Mar. 31 - Apr. 2	Apr. 1
20.01 Thallophyte	Apr. 9	Apr. 8
Test III	Apr. 11	Apr. 10
20.02 Embryophyta	Apr. 14 - 16	Apr. 15
21.01 Protozoa and Porifera	Apr. 18 - 21	Apr. 17
21.02 Coelenterates and Platyhelmenthes	Apr. 23 - 25	Apr. 22 - 24
21.03 Aschelminthes etc.	Apr. 28 - 30	Apr. 24 - 29
21.04 Echinodermata and Chordata	May 2 - 5	May 1 - 6

Appendix XX (continued)

Appendix III

QUESTIONNAIRE ABOUT GENERAL BIOLOGY October 31, 1979

During the past two years, the Biology Department has spent considerable time and effort developing the course in which you are now enrolled. We are now seeking student input as we attempt to evaluate the various components of it. Would you please assist us in this effort by indicating the degree to which you agree with each of the following statements about the various parts of the course. The evaluation scale is:

5--strongly agree with the statement
4--agree with the statement
3--am neutral toward the statement (i.e. neither agree nor disagree)
2--slightly disagree with the statement
1--strongly disagree with the statement

Objectives in the Handbook:

1. I read the objectives for the modules.....5 4 3 2 1 — 36% 48% 12% 3% 2%
2. The objectives help me understand what I should study.....5 4 3 2 1 — 40% 38% 15% 5% 1%
3. The objectives help me pass the quizzes and tests.....5 4 3 2 1 — 24% 35% 27% 10% 3%
4. The objectives group too many ideas together. It would be better if they were split up into more objectives covering single ideas .....5 4 3 2 1 — 9 23 26 26 15
5. The objectives are a complete waste of paper--they should be eliminated ...5 4 3 2 1 — 1 5 9 15 70

OTHER COMMENTS ON OBJECTIVES:

Sample Problems in the Handbook:

6. I work the sample questions in the modules.....5 4 3 2 1 — 42% 42% 13% 2% 1%
7. The sample questions are similar to the ones on the test.....5 4 3 2 1 — 14% 36% 24% 14% 8%
8. The sample questions help me pass the tests.....5 4 3 2 1 — 23% 32% 27% 13% 4%
9. There are not enough sample questions. There should be more.....5 4 3 2 1 — 14% 16% 31% 31% 8%
10. There are too many sample questions. There should be fewer.....5 4 3 2 1 — 0 6% 21% 36% 36%
11. The sample questions are a complete waste--eliminate them.....5 4 3 2 1 — 1% 4% 7% 15% 73%
12. There is no need to leave space to answer the questions in the book.....5 4 3 2 1 — 17% 4% 7% 15% 72%

OTHER COMMENTS ON SAMPLE QUESTIONS:

Alternate Pathways to Learning:

13. I go to the APLC often to study Biology.....5 4 3 2 1 — 15% 25% 24% 17% 18%
14. The APLC is a benefit to Biology students.....5 4 3 2 1 — 34% 38% 25% 2% 1%

Appendix XX (continued)

5. I use the tapes and filmstrips often.	8%	21%	24%	26%	20%	
	5	4	3	2	1	
6. The tapes and filmstrips help me learn the material in the modules.	9	22	36	17	15	
	5	4	3	2	1	
7. I use the Biology tutoring services in the APLC often.	8	21	27	22	21	
	5	4	3	2	1	
8. The Biology tutoring in the APLC is good. The Biology tutors are helpful and available when they are scheduled to be.	12	19	46	8	14	
	5	4	3	2	1	
19. I use my Biology Handbook often.	41	36	16	3	3	
	5	4	3	2	1	
20. The Biology Handbook helps me. I am getting a better grade than I would get if it weren't available.	33	25	33	4	5	0
	5	4	3	2	1	

OTHER COMMENTS ABOUT THE ALTERNATE PATHWAYS TO HELP YOU LEARN:

Other:

48	24	16	7	5		
5	4	3	2	1	:	21. In a typical college course, three or four (plus a final) tests are given. In this course, having 10 quizzes and 3 hour-tests is better because there is less material covered on each quiz/test.
32	34	24	5	4		
5	4	3	2	1	:	22. I like tests that have both multiple choice items and "problems".
57	23	16	1	2		
5	4	3	2	1	:	23. I study for this course to learn the material rather than just to pass a test, because I know the final will be a killer.

OTHER COMMENTS ON OTHER:

I am a DNR student. 61 as 53 in

Appendix IV

Appendix XX (continued)

123

4

J. Hunter

Fall, 1979

182

A		15	8	
B	45%	34	19	59%
C		59	32	
D		36	20	
E	55%	35	19	41%
W		3	2	

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Diplomas (123) 124

Appendix V

SEMESTER	COURSE LEADER	NUMBER OF SECTIONS	TOTAL ENROLLED	MEAN GPA XU EXAM	MEAN GPA ST. EXAM	GRADE DISTRIBUTION A	B	C	D	F	
1978-79 FALL	D Hunter	4	162				49.99%				
SPRG		2	84				51.19%				
1979-80 Falf	D. Hunter	4	182			15 - 8%	34 - 19%	59 - 32%	36 - 20%	35 - 19%	2%
Spring		2					59%				

Appendix XX (continued)

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Biology 123-124

Appendix V

SEMESTER	COURSE LEADER	NUMBER OF SECTIONS	TOTAL ENROLLED	MEAN ON XU EXAM	MEAN ON ST. EXAM	GRADE DISTRIBUTION # & % A	# & % B	# & % C	# & % D	# & % F	# & %
1978-79 FALL											
SPRG	J. Hunter	3	99				88.88%				
1979-80 Fall		1	41			5-12	12-29 90%	20-49	4-10	0	
Spring											

Appendix XX (continued)

Dr. Carmichael

Appendix XXI--Chemistry's Plans for Continuation of Activities after Grant

December 12, 1979

Continuation of the Genral Chemistry Program after CAUSE

The following represent some suggestions for maintaining a smoothly run General Chemistry sequence once the CAUSE grant expires. Special emphasis is placed on how new faculty may be easily integrated into the system, how the course may be updated utilizing both faculty and student input, the development of a timetable to insure smooth running of the course, and the maintenance of the Alternate Pathways Learning Center.

I. INTEGRATION OF NEW FACULTY:

A. Initial meetings with faculty already working in General Chemistry, in order to allow new faculty to:

1. obtain background information on the development of the course and to gain insight as to why we have this type of course rather than a traditionally taught course here at Xavier.

2. become familiar with course materials--Handbook, text, module tests, lab manual.

3. become acquainted with the course structure (lecture, lab, and drill) by running through the "mechanics" on paper. Appendix I.

B. Weekly meetings throughout the semester, of General Chemistry faculty to talk over what is happening in the various parts of the course--what works, what appears not to work, attempting to iron out difficulties and to answer questions as they arise.

C. Timetable for Chemistry 101-102. Appendix II.

II. UPDATING THE COURSE VIA INPUT FROM STUDENTS AND FACULTY:

A. Questionnaire at mid-semester to get a feel for what students are ~~thin~~ thinking and feeling about the course, whether or not they are using the supports that are built into the course (handbook, tapes, tutoring services, etc.).
The results are tallied, reviewed by General Chemistry faculty, and feedback and/or clarification are given to students by faculty when needed. Appendix III.

B. Statistics at mid-semester and end of semester. Appendix IV

C. Weekly meetings of General Chemistry provide a valuable and continuous source of input into the course particularly from new faculty who hopefully begin to feel as though the course is his/her own because of this investment that is made.

D. Since the material to be covered in the general Chemistry course is determined by the Chemistry Department as a whole, there is a need for periodic input from the Chemistry faculty into the course. As a means to this end, one Chemistry staff meeting in the spring semester of each year might be devoted to reviewing the material in the course, evaluating the objectives and making any additions and deletions that seem appropriate. N.B. Any additions to the course material must be accompanied by the deletion of an equivalent amount of material.

III. Maintenance of the APLC:

A. The Chemistry department will be represented by one faculty member and one student tutor on the APLC Committee.

B. Training session for tutors who will be working in the APLC (along with those who work in the drills as learning assistants).

Appendix I

Appendix XXI (continued)

CHECKLIST FOR RUNNING DRILLS

1. Get set of four keys for drill from JWC's Office.
2. Open the door at the far end of the MSL (the one closest to the Quant. Lab).
3. Unlock the file cabinet with tests and the cabinet with the answer books .
4. Count the grade books to see that all four are there.
   (If not see me immediately.)
5. Let anyone who wishes take the test start. Remember that people from other drills need a slip to come in.
6. By 15 minutes after the beginning of the drill, everyone has to start taking a test.
7. As soon as everyone starts taking the test, you should:
   a) write the CHALLENGE QUESTION for the drill on the board and encourage them to work it,
   b) take roll (AND KEEP IT JUST LIKE YOU DO GRADES),
   c) complete, sign, and put in campus mail absence slips for Sr. Miriam Francis, (YOU MUST DO THIS, IF YOU AREN'T WILLING TO TAKE THE RESPONSIBILITY WITH THIS JOB, THEN QUIT NOW.)
   d) Put two bonus problems on the board.
8. The students have 45 minutes to take the test so that by the end of the first hour you should collect everyone's test.
9. As soon as students finich the exam (even if the 45 minutes isn't up), start grading. You should grade all tests as rapidly as possible and be finished by 15 minutes after the end of the first hour. Students should pair up and work bonus question while you grade.
10. Students who get 90% (9 of 10 questions) are free to leave as soon as you record their grade. Remember the +1 point (if applicable). They can take the test with them. Also record bonus point.
11. All other studnets remain in drill (or are reported as absent). Spend the next 45 minutes (the last 45 of the 2nd hour) going over what they missed. It is better if you get them working in groups, using the chalk board, etc.
12. At the beginning of the 3rd hour, all who haven't passed a test take another version. Again, they have 45 minutes--with no Challenge question possible.
13. You should spend the last 15 minutes grading the tests, signing slips to attend other drills IF THE STUDENT CAME AND STAYED THE WHOLE TIME IN YOURS.

14. At the end of the period, you should
    a) make sure you have a record of everyone's progress,
    b) turn in a list of those behind to Jacinta,
    c) count and make sure the grade books are all in the cabinet,
    d) lock the file cabinet and the grade book-cabinet,
    e) return keys to JWC, have a GOOD STIFF DRINK. GOOD LUCK!
    f) lock the other door of the MSL.

Appendix II

TIMETABLE FOR CHEMISTRY 101-102

ACTIVITY	DATE (approximate)
Handbook Revisions	Feb. 1
Lab Manual Revisions	Feb. 1
Review/Revision of module tests	Feb. 1
Chemistry Staff meeting to review General Chemistry course material	March 1
Course plans	Beginning of each semester
Questionnaires	Mid-semester
Statistics	Mid and end of semester
Exams	
Lecture	Dec. 1/ April 15
Lab	Dec. 1/ April 15
Ordering of supplies	
Binders	March 1
Textbooks	April 1
Duplication--Printing Office	
Handbook	March 15
Lab Manual	March 15
Final Exams	Dec. 8/ April 21
Duplication	
Module tests	May 31
Forms	

Appendix XXI(continued)

Appendix 3

QUESTIONNAIRE ABOUT GENERAL CHEMISTRY

October 22, 1979

During the past two years, the Chemistry Department has spent considerable time and effort developing the course in which you are now enrolled. We are now seeking student input as we attempt to evaluate the various components of it. Would you please assist us in this effort by indicating the degree to which you agree with each of the following statements about the various components of the course. The evaluation scale is:

5--strongly agree with statement
4--agree with the statement
3--am neutral toward the statement (i.e. neither agree nor disagree)
2--slightly disagree with the statement
1--strongly disagree with the statement

Objectives of the Handbook:	5	4	3	2	1
1. I read the objectives for the modules	43%	40%	16%	3%	1%
2. The objectives help me understand what I should study	54%	36%	6%	3%	3%
3. The objectives help me pass the quizzes and reviews	41%	43%	16%	6%	4%
4. The objectives group too many idea together. It would be better if they were split up into more objectives covering fewer ideas	14%	6%	29%	27%	22%
5. The objectives are a complete waste--eliminate them	4%	3%	1%	7%	84%

OTHER COMMENTS ON OBJECTIVES:

Sample Problems on the Handbook:					
6. I work the sample problems in the modules	61%	34%	8%	0%	0%
7. The sample problems are similar to the ones on the module	45%	34%	10%	7%	1%
8. The sample problems help me pass the module tests	51%	25%	7%	7%	4%
9. There are too many sample problems. There should be fewer	6%	7%	16%	21%	51%
10. There are not enough sample problems. Add more	14%	6%	34%	16%	19%
11. The sample problems are a complete waste--eliminate them	3%	3%	0%	9%	80%
12. There is no need to leave space to work on the problems	6%	6%	6%	7%	70%

OTHER COMMENTS ON SAMPLE PROBLEMS:

Sample Review Tests in the Handbook:					
13. I go through the sample reviews in the handbook before Reviews	69%	21%	4%	7%	0%
14. The sample reviews are similar to the real Reviews	46%	30%	11%	9%	3%
15. The sample Reviews are good. They should be retained	69%	20%	7%	1%	0%

OTHER COMMENTS ON SAMPLE REVIEWS:

Alternate Pathways to Learning:					
16. I go to the APLC often to study Chemistry	24%	34%	21%	9%	9%
17. The APLC is a benefit to Chemistry students at XU	50%	36%	11%	3%	0%

Appendix XXI (continued)

18. I use the taped lectures often 15% 23% 10% 10% 38%
19. The taped lectures help me learn the material in the modules.. 25% 25% 20% 8% 28%
20. I use the Chemistry tutoring services in the APLC often..... 20% 20% 38% 5% 20%
21. The Chemistry tutoring in the APLC is good. The Chemistry tutors are helpful and available when they are scheduled to be..... 35% 38% 18% 3% 5%
22. I use my General Chemistry Handbook often..... 75% 15% 3% 3% 0%
23. The Chemistry Handbook helps me. I am getting a better grade than I would get if it weren't available..... 63% 25% 5% 0% 0%

OTHER COMMENTS ABOUT THE ALTERNATE PATHWAYS TO HELP YOU LEARN:

Chemistry's individualized system of Teaching:

In addition to the Handbook, tapes, tutoring, etc., the General Chemistry course is "individualized" with lots of small tests, instant gracing, optional points, etc. The following considers a number of these.

24. I have more contact with instructors in General Chemistry than in other courses. (Remember that it is "team taught" with Carmichael, Wells, and Williams involved in various roles.)..... 43% 20% 15% 0% 10%
25. I like the system because I can re-take tests on which I do poorly. 75% 20% 5% 0% 3%
26. Module tests are easier than those in regular courses because each covers less material..... 33% 25% 28% 5% 10%
27. I like being able to use calculators on the tests..... 65% 15% 18% 0% 0%
28. I like knowing exactly what will be on each test. It makes it easier to study..... 63% 15% 20% 3% 0%
29. I like "instant grading" of module tests..... 80% 15% 5% 0% 0%
30. The course is structured such that I got to know other students rapidly and hence was able to benefit from mutual experiences such as borrowing notes, discussing problems, passing answers on tests, etc. 50% 18% 15% 3% 13%
31. I learn more in Chemistry taught this way than I would have in a course taught in the traditional manner..... 55% 25% 18% 0% 0%
32. I spend more time studying Chemistry that I think I would have if the course had been taught traditionally..... 43% 23% 20% 10% 5%
33. I study for this course to learn the material rather than just kto pass a test..... 40% 33% 23% 0% 25%

Appendix XXI (continued)

34. There is less pressure on me while taking an exam in General Chemistry than there is in taking a traditional "hour exam" because I know I can re-take it..... 43% 18% 10% 8% 13%

35. I like the fact that I can make up missed points by completing optional modules..... 76% 15% 3% 0% 0%

36. I like tha fact that I know exactly how many points I need for an "A" in advance so that I can work toward that grade all the time. 85% 10% 3% 0% 0%

Chemistry 101

Appendix IV

Year & Semester	Number of Dr'll Sections	Total Number Enrolled	Mean on XU Exam	Mean on Standardized Exam	Grade Distributions # & %							Grade Dist. of those taking "DC" # & %						
					A	B	C	D	F	W	DC	A	B	C	D	F	W	
1979 Fall																		
1980 Spring																		

Appendix XXI (continued)

Appendix XXII--Mathematics' Plans for Continuing Activities After Grant Expires

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411

TO: Dr. JW Carmichael, Director of Xavier's NSF-CAUSE Project

FROM: L. W. Jones, Jr., Mathematics Representative for CAUSE

DATE: November 30, 1979

RE: Continuation of the Mathematics portion of the CAUSE Project

When Xavier's NSF-CAUSE proposal of 1978 was written the mathematics department, as well as the other science departments, agreed to continue the proposed program after NSF funding ended. The mathematics portion of the grant was aimed at providing a coordinated, standardized approach to the teaching of Precalculus and Introductory Calculus. In order to maintain this coordinated approach, the department has chosen to have the chairman appoint each semester a course leader for each of Precalculus and Introductory Calculus who will supervise these courses.

Furthermore, in order to coordinate the other multisection courses in the department, a section leader will be appointed for them also. This decision points out the responsiveness of our department to new ideas and our willingness not only to maintain the NSF-CAUSE program but to apply its good ideas to other courses as well. The duties of the course leaders are detailed in the following appendix.

All aspects of the continuation of the CAUSE program were discussed in our staff meeting of November 29, 1979. The decisions were reported in our staff minutes, an excerpt of which is included in an appendix to this memo.

LWJ:bi

Appendix XXII(continued)

(Exerpt from)

Minutes of Staff Meeting for the

Department of Mathematics and Computer Science

November 29, 1979

All Staff members present.

Our department's mechanisms for retaining the improvements funded by CAUSE are five-fold:

Maintenance of coordinated approach

1) Course leaders will be designated each semester for all multi-section courses, in addition to Precalculus and Introductory Calculus. These course leaders will serve as coordinators of the various sections. Their duties are given in detail on an accompanying memo. The course leaders for Spring 1980 will be: Math Review - Dr. Fontova; Math 1010 - Mr. Turner; Math 1020 - Sr. Eileen; Math 1030 - Dr. Irlbeck; Math 1040 - Mr. Bill Jones.

Integration of New Faculty into Departmental Systems

2) New faculty will be integrated into the system via weekly departmental meetings and by the course leaders of the courses they are teaching. Course leaders are expected, therefore, to actively seek the opinions of the new faculty concerning the courses, as well as informing these new faculty of the history of the development of the courses.

Maintenance of data collection and on-going course evaluation

3) The course leaders are responsible for collecting the data and disseminating the results of the evaluation to the departmental faculty. These duties are detailed on an accompanying memo.

Maintenance of course syllabi

4) Mr. Jones will have the responsibility for seeing that the course syllabi for Math Review, Precalculus and Introductory Calculus will be printed and made available for the students to purchase. This procedure is to be detailed on an accompanying memo so that, if necessary, someone else could carry this out.

Maintenance of APLC activities

5) The chairman will appoint an APLC Director who will insure that the activities of the Mathematics area are effectively and efficiently carried out. This includes selecting the tutors, overseeing the tutoring, updating the list of alternate pathways as new materials come in, representing the department on the APLC committee, and other duties as the chairman sees fit to assign.

Appendix XXII (continued)

DUTIES AND RESPONSIBILITIES OF COURSE LEADERS

IN THE DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Each course leader is expected to:

1. Prepare a day-by-day outline for the semester detailing the material to be covered each class meeting and provide a copy to each instructor.

2. Meet with the other teachers individually or in groups on a regular basis to coordinate the teaching and provide a forum for discussion of the content of course, textbook, alternate pathways, etc.

3. Prepare in conjunction with the other teachers of the course a common final examination for the course.

4. Collect copies of each instructor's hour exams as well as a copy of midterm grades and final grades.

5. As soon as possible after mid-term, compute a grade distribution for each section as well as for the combined group. This grade distribution should show the precentage of students making at least a C and those making below a C. Also a student-attitude question should be distributed to all sections and the results tabulated.

6. At the end of the semester, collect a copy of class roll from each section's instructor containing name, final exam score, (plus standardized test score, if a standardized test is given), and final course letter grade for each student. Each instructor is to submit class average on the final exam (plus standardized test, if any is given) and grade distribution for his or her section.

7. Calculate over all average on final exam (plus average on any standardized test given) and overall grade distribution. This data is to be recorded on the course leader report form (see appendix) and placed in the departmental files. This information to be recorded on the department's master sheet in the departmental file.

COURSE LEADER'S REPORT

COURSE: MATH _____ COURSE LEADER _____ SEMESTER _____

Appendix XXII (continued)

NUMBER OF SECTIONS _____ TOTAL ENROLLMENT _____

MEAN ON XU EXAM _____ MEAN ON STANDARDIZED EXAM _____

PERCENTAGE OF STUDENTS TAKING XU EXAM _____ PERCENTAGE OF STUDENTS TAKING ST. EXAM _____

	GRADE DISTRIBUTIONS			
	MIDTERM		FINAL	
GRADE	NUMBER	PERCENT	NUMBER	PERCENT
A				
B				
C				
D				
F				
W				
DC				

APPENDICES TO BE ATTACHED TO THIS FORM:

1. ~~a~~ copy of each form of XU common exam
2. instructor's reports from each section
3. results of midterm student-attitude questionaire
4. copy of day-by-day outline given to instructor

3. copies of each instructor's raw data

COMMENTS (include any other pertinent information about the course such as any other data collected or parameters computed.)

_____

COURSE LEADER'S SIGNATURE

Appendix XXII (continued)

QUESTIONNAIRE ABOUT PRE-CALCULUS FALL SEMESTER 1979

During the past two years, the Mathematics Department has spent considerable time and effort developing the course in which you are now enrolled. We are now seeking student feedback in an effort to further improve it. Would you please assist us by indicating the degree to which you agree with each of the following statements about the various components of the course by circling the number corresponding to your attitude about the statement. The evaluation scale is:

5 -- strongly agree with the statement
4 -- agree with the statement somewhat
3 -- am neutral toward the statement
2 -- slightly disagree with the statement
1 -- strongly disagree with the statement

Objectives in the Handbook:	5	4	3	2	1
1. I read the objectives often.	22%	38%	20%	14%	7%
2. The objectives help me understand what I should study.	34%	28%	18%	14%	6%
3. The objectives help me pass the quizzes and reviews.	23%	28%	23%	27%	9%
4. The objectives group too many ideas together. It would help if they were split up into smaller ideas.	11%	13%	31%	23%	21%
5. The objectives are a complete waste of paper. I vote they be eliminated from the handbook next year.	5%	3%	7%	9%	77%

Comments:

Sample Problems in the Handbook:					
6. I work the sample problems.	54%	30%	10%	3%	1%
7. The sample problems are similar to the ones in the test.	48%	30%	11%	9%	2%
8. The sample problems help me pass the test.	44%	29%	16%	7%	4%
9. There are too many sample problems. It would be easier to focus on what is important if there were fewer.	5%	7%	14%	28%	44%
10. There are not enough sample problems. I find it difficult to work test questions because the sample problems didn't provide enough practice.	11%	7%	20%	32%	29%
11. The sample problems are complete waste of paper.	4%	1%	3%	9%	82%
12. The sample problems are helpful, but I vote to get rid of the space to work them in the Handbook.	5%	6%	11%	11%	67%

Comments:

Appendix XXII (continued)

	5	4	3	2	1
Sample Tests in the Handbook:					
13. I go through the sample test in the handbook before the real test.	73%	18%	6%	1%	1%
14. The problems on the sample test are similar to those on the real tests my instructor gives in class.	42%	32%	10%	11%	4%
15. The sample tests are a good part of the course. I vote to keep them.	80%	13%	4%	.6%	1%
Comments:					
Alternate Pathways to Learning:					
16. I go to the APLC often to study mathematics.	14%	11%	18%	21%	34%
17. I use the taped lectures often.	5%	10%	18%	20%	47%
18. The APLC is a benefit to science students at Xavier.	48%	23%	18%	2%	6%
19. The taped lectures help me learn the material in the modules.	12%	10%	40%	11%	21%
20. I use the tutoring services in the APLC often.	21%	17%	20%	14%	27%
21. The mathematics tutoring in the APLC is good. The mathematics tutors are helpful and available when they are scheduled to be.	14%	16%	45%	8%	11%
22. I bought the Handbook for this course.	86%	6%	2%		5%
The Handbook helps me. I am certain I have a better grade than I would have if it weren't available.	43%	22%	19%	9%	5%
Comments:					
Miscellaneous:					
24. Having a Handbook with taped lectures is worth the price I paid for the Handbook.	34%	21%	30%	6%	3%
25. My instructor makes sure that we use the Handbook by reminding us of the sample problems, sample tests, etc. and by using the Handbook to guide the lectures in class.	62%	21%	9%	3%	1%

Appendix XXII (continued)

26.	In a typical college course, only 3 or 4 tests (plus a final) are given. In this course, there will be 6 tests (plus a final). Having a greater number of tests is better.	65%	18%	9%	5%	1%
27.	I like being able to use calculators in the tests.	41%	10%	33%	5%	8%
28.	I like knowing exactly what will be on each test. It makes it easier to study.	64%	15%	11%	3%	2%
29.	I got to know other students in the course and was able to benefit from mutual experiences (borrowing notes, discussing problems, etc.).	22%	28%	31%	6%	9%
30.	I learn more in Mathematics this way than I would have in a traditional Mathematics course.	38%	27%	23%	5%	4%
31.	I spend more time studying Mathematics taught this way than I would have if it were taught traditionally (without a Handbook, tapes, etc.)	30%	24%	26%	4%	12%
32.	I study for this course to learn the material rather than just pass a test because I know the final is going to be a killer.	44%	24%	18%	6%	5%
33.	I do not need the Handbook for this course because I know the material already.	1%	6%	16%	18%	55%
34.	I do not need the handbook for this course because it does not follow what my instructor does in class.	0%	3%	8%	13%	73%

Comments:

Appendix XXIII--Physics' Plans for Continuation after Grant Expires

Xavier University of Louisiana
NEW ORLEANS, LOUISIANA 70125, TELEPHONE 504/486-7411
College of Arts and Sciences

TO: Dr. JW Carmichael, Director of NSF-CAUSE Project,
Xavier University of Louisiana

FROM: Harold A. Vincent, Physics/Pre-Engineering Department
and CAUSE Committee Representative

DATE: January 23, 1980

SUBJECT: Continuation of the Physics Portion of the CAUSE Project

When the Xavier University CAUSE proposal of 1978 was written, the Physics/Pre-Engineering Department agreed to continue the proposed program beyond the period funded by the NSF. At the time that the project was funded, a single faculty member taught the lecture classes directly affected by the project, and the same person and one other were responsible for the laboratory classes affected. With the increase in the numbers of students enrolling in these courses and, hence, the increase in the number of class sections and faculty teaching them, it is necessary to establish a written departmental policy on the continuation of the physics component of the CAUSE project.

Maintenance of Coordinated Approach

1) The Department Chairman will designate, in the spring semester, course leaders who will be responsible for coordinating course activities and schedules during the following school year. One course leader will be named for the lecture sections of Physics 2010-20 and one for their laboratory complements, Physics 2010-20LB.

   Each course leader is expected to:

   a) prepare syllabi for the courses
   b) arrange a schedule (when) and plan (what is included) for quizzes, tests, examinations, homework assignments and (laboratory) exercises.

c) meet with the teachers of the various sections individually or in groups on a regular basis to coordinate the teaching and provide a forum for discussion of contemporary problems of the courses.
d) prepare, in conjunction with the teachers of the other sections, a common final examination.
e) collect copies of the teachers' quizzes and tests and midterm and final grades.
f) As soon as possible after midterm, compute a grade distribution for each section as well as for the combined group. The distribution should show the percent of students making a C or better and that of the students making below a C. Also, a student attitude questionnaire (already prepared) should be completed by students in all sections and the results tabulated and distributed to the teachers.

Integration of New Faculty into Departmental Systems

1) In pre-hiring discussions, the Department Chairman will describe to the prospective faculty member the physics component of the CAUSE project.
2) In initial meetings with the newly hired faculty, the department's CAUSE coordinator will provide background information on the development of the general physics course, and the accomplishments to date.
3) The new faculty member will be given a Physics Manual so that he/she will become familiar with its content materials. An explanation of how the materials are used in the course will be provided.
4) Special attention will be devoted to ensuring that the new faculty member understands the objectives and mechanics of the Piagetian-based laboratory exercises.
5) The new faculty member will be given a tour of the Alternate Pathways Learning Center, with a discussion of tutoring, computer terminals, filmstrips and tape cassettes, and the grading machine.
6) Weekly meetings will be held by teachers of the general physics course in order for each to be made aware of what is happening in the various parts of the course -- what is working, what appears not to be working, attempting to correcting the difficulties and answering questions as they arise.

Maintenance of Data Collection and Course Evaluation

The course leaders are responsible for collecting data and disseminating the results of the on-going evaluation conducted around the midterm of the semester. The Department Chairman will be responsible for the end-of-course evaluation.

Maintenance and Revisions of Physics Manual

1) Professor Vincent will be responsible for revisions of the Physics Manual. Additions, deletions and alterations should be agreed upon by department faculty and submitted to Prof. Vincent for inclusion in the manual.
2) The Department Chairman will be responsible for ordering and having available (in the bookstore) on the first class day of the fall semester the appropriate number of manuals.

Maintenance of APLC Activities

The Department Chairman will appoint an APLC coordinator, who will ensure that the activities of the Physics area are effectively and efficiently conducted. These include selecting tutors, arranging the tutoring schedule, monitoring of tutoring activities, keeping current the list of APLC learning materials, representing the department on the APLC Committee, selecting a student representative on the APLC Committee, and other duties deemed necessary by the chairman.

Appendix XXIII (continued)

COURSE LEADER'S REPORT

COURSE: PHYS. _____ SEMESTER _____ COURSE LEADER _____

MEAN ON XU EXAM _____ MEAN ON STANDARDIZED EXAM _____

STUDENTS TAKING XU EXAM
NUMBER_____ PERCENT_____

STUDENTS TAKING STANDARDIZED EXAM
NUMBER_____ PERCENT_____

	GRADE DISTRIBUTION			
	MIDTERM		FINAL	
GRADE	NUMBER	PERCENT	NUMBER	PERCENT
A				
B				
C				
D				
F				
W				
I				

Appendix XXIV

Journal of Developmental & Remedial Education

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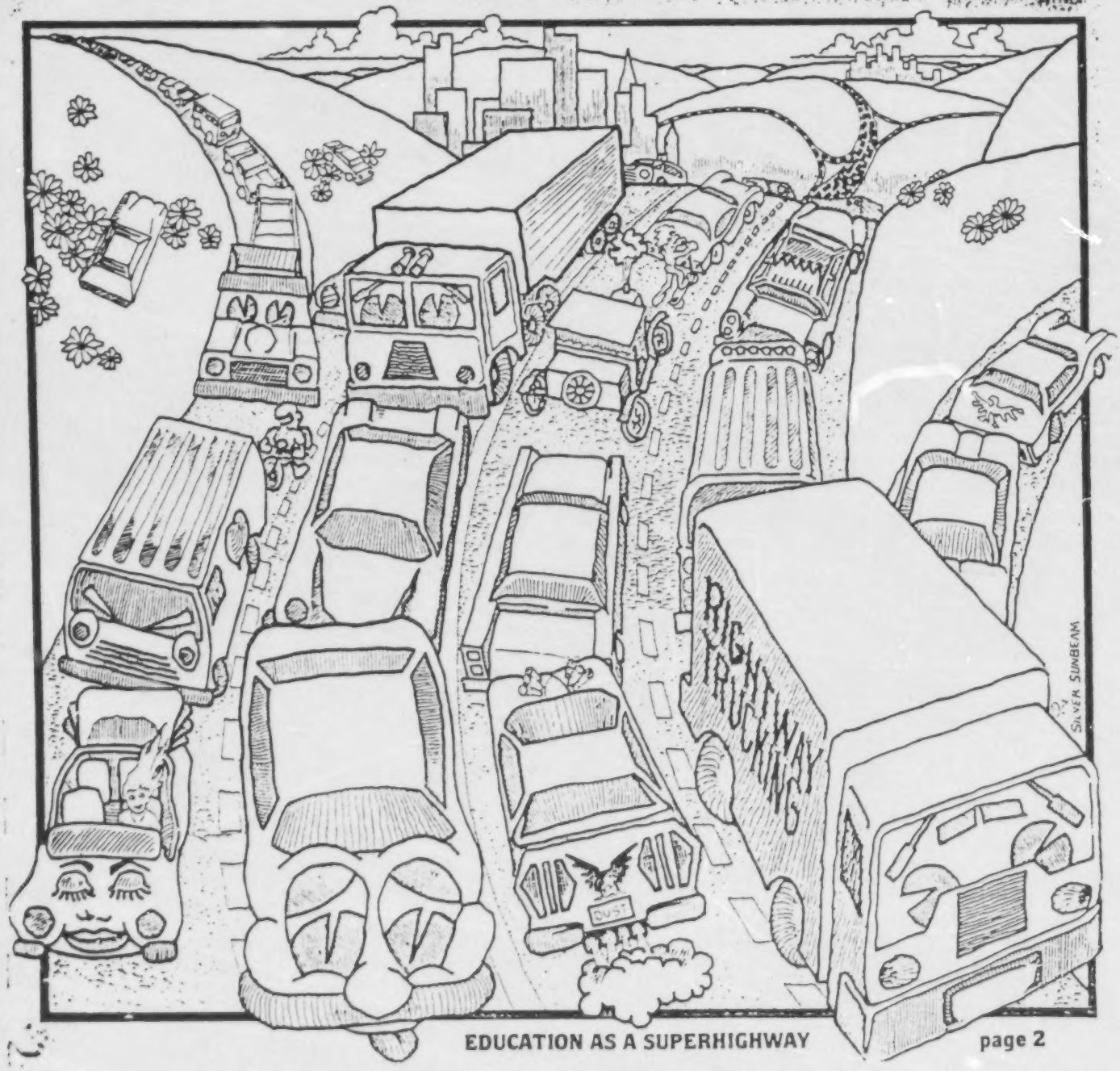

EDUCATION AS A SUPERHIGHWAY page 2

COGNITIVE SKILLS ORIENTED PSI IN GENERAL CHEMISTRY

by J.W. Carmichael, Jr., Mary Ann Ryan, and Arthur Whimbey

One of the major problems facing college-level science faculty is how to increase access to science-related careers for the educationally disadvantaged without sacrificing quality education. This problem is especially acute in entry-level courses. The most common solution has been to develop "prep" science courses that precede the entry-level ones which are then taught in the traditional manner. An alternative approach is to modify teaching techniques in entry-level courses so that both the well-prepared *and* the educationally-disadvantaged have a reasonable chance for success. The latter has been used at Xavier University of Louisiana, a small predominantly-Black institution in New Orleans, to develop a general chemistry sequence for science majors which has proven effective as measured both by standardized testing and student response.

The general chemistry sequence at Xavier is conducted in a modified PSI (Personalized System of Instruction) format. The modifications are based on research at Xavier and other institutions (e.g., Cross, 1976; Whimbey, Bovlan, and Burke, 1979) that have identified both the strengths of PSI for educationally disadvantaged students and also special problems such students are likely to encounter with PSI. The first phase of the development of the sequence was briefly outlined in a previous report (Carmichael, 1976). This paper describes the current form of the course, with special emphasis on those aspects designed to assist the educationally disadvantaged student.

Course Materials

1. *Chemistry: The Central Science* by Brown and Lemay (Prentice-Hall).
2. *General Chemistry Handbook* by Carmichael and Ryan (locally produced).
3. *General Chemistry Laboratory Manual* by Ryan and Carmichael (locally produced).
4. Organic Chemistry Molecular Models (Benjamin Maruzen).
5. Audio tapes to supplement the text and lectures (locally produced).
6. Calculators with logs, trigonometric functions and scientific notation.
7. Standard chemistry laboratory equipment.

Course Structure

1. A two-semester sequence with separate lecture and laboratory courses.
2. Two 1-hour lectures per week.
3. One 3-hour cognitive therapy-oriented drill per week.
4. One 3-hour Piagetian-based laboratory per week.
5. Approximately 20 hours per week free tutorial service by a staff person.

J. W. Carmichael, Jr. and Mary Ann Ryan, Professors of Chemistry, and Arthur Whimbey, Visiting Professor in Reading Special Services, at Xavier University of Louisiana, New Orleans, LA 70100.

Course Description

The core of the general chemistry for science majors at Xavier is the *Handbook* by Carmichael and Ryan. It is composed of a series of lecture text modules which contain clearly written objectives, assignments in the textbook, sample problems, and other learning activities. The handbook makes it possible to provide the basic structure of PSI, namely a series of limited, well-defined units, each of which must be mastered before the student proceeds to the next. It also provides a framework for a number of teaching strategies developed to assist educationally disadvantaged students. These included the following:

1. Retention of Lectures. Although a complete set of scheduled lectures for all topics is not a part of standard PSI, lectures have been retained in the general chemistry sequence at Xavier because it has been found that they provide an additional learning source for the educationally disadvantaged as well as a guide and pacing device for the entire class. Records show that approximately 60% of the students attend regularly even though attendance is not required *and* the class is scheduled at 8:00 AM. To encourage the development of the analytic thinking skills necessary for successfully completing a rigorous general chemistry course, new topics are generally introduced by analyzing data similar to that obtained in the laboratory.

2. Cognitive Therapy-Oriented Weekly Drill Sessions. The three-hour weekly drill sessions are used for administering the posttests for the modules and for tutoring to teach both chemistry content and thinking skills. Whereas the total registration for general chemistry is generally 180-200 students per semester (all of whom are enrolled in one lecture section), drill sessions are limited to only 25 students and are staffed by an instructor and two or three advanced students called "learning assistants." Students are strongly encouraged to prepare for the exam before coming to the drill and are required to take at least one quiz each drill period after a maximum of 20 minutes for review and tutoring. When a student completes a quiz, it is graded immediately by the instructor or a learning assistant. As in standard PSI, the student is required to engage in additional study and then take another form of the quiz if his or her score is not satisfactory. Because there is a maximum of 25 students in a drill section with an instructor and two or three learning assistants, an appreciable amount of time and personal attention can be given to students with learning difficulties.

Learning assistants have been trained to engage in "cognitive therapy" tutoring. They do not just give answers or demonstrate the way a problem can be solved. Instead they help students find answers for themselves. This may mean guiding a student in carefully reading a section of the text or asking a probing question which suggested the way a problem can be solved or a conclusion can be reached from knowledge available to the student. In addition, students are frequently asked to explain all of the steps in reaching an answer, especially if the answer is wrong, but also whenever the tutor suspects that a student's understanding of a topic is inadequate. In demonstrating how a particular type of problem is solved, the tutor may instruct the student and provide explanations, but he or she requires the student to carry out the actual activities and computations. The tutor never simply works a problem leaving the student to watch. After helping a student to solve a problem, the tutor then asks the student to solve one or more additional problems and to explain the steps as he or she proceeds. Throughout tutoring, the tutor constantly watches for instances where a student arrives at an answer without sufficient concern for accuracy, reasons or necessary cognitive steps. The tutors understand that their goal is *both* to teach chemistry *and* to eliminate the student's need for tutoring. (See Whimbey and Lochhead, 1979, for a more detailed discussion for teaching analytical skills.)

3. Taped Lectures. In order to provide additional oral instruction to those students who prefer or need such assistance, a complete set of locally-produced lecture tapes is available on cassette. These tapes are not merely reproductions of the regular lectures, but rather are especially prepared so as to cover an entire module (approximately one week's work) in one hour. The tapes are available in Xavier's Alternate Pathway Learning Center where they may be checked out for use there *or* for rapid duplication onto the student's own cassette for use at home. Although, as expected, this alternate learning mode is most popular with students who have reading difficulties or those who are behind or ahead of the regularly scheduled lectures, they are also regularly used by more than half of the remainder of the class.

4. Review of Mathematics. To alleviate the math difficulties educationally disadvantaged students often experience in chemistry, review modules covering algebra, graphing, significant figures, quadratic equations, and logarithms are included in the *Handbook* just prior to topics requiring this mathematics. Students are required to complete these modules to mastery-level in sequence for which they receive course

of the just as with the modules covering chemistry content. In addition, students are encouraged to purchase and use calculators because doing so reduces computational labor and errors, and leaves more time to treat development of concepts.

5. Minimizing Procrastination. Standard PSI allows students to progress at their own pace. However, experience at Xavier, confirmed by other educators (Cross, 1976), indicates that procrastination is a special problem in attempting to use PSI with educationally disadvantaged students. Therefore, although the sequence at Xavier officially allows self-pacing, considerable effort has been devoted to devising schemes to detect procrastination early and to encourage staying up with or ahead of a published "ideal schedule" as follows:

First, students can earn bonus points on module tests if they complete the tests on or ahead of the schedule.

Second, students from each drill section are encouraged to work together, and the progress of each drill section is reported weekly to the course lecturer (by the drill instructors) so that both lecturer and drill instructor can easily keep track of progress and work together to contact those students who appear to be falling behind.

Fourth, all students who are behind the ideal schedule each week are sent a letter informing them of their progress, encouraging them to catch-up, and reminding them of the opportunities for tutoring, etc.

6. Required Use of Molecular Models. Chemistry, by its very nature, demands a great deal of abstract thought and conceptualization. In order to assist the education- ally disadvantaged, considerable effort is made to use models, simulations, demonstra- ons, etc. which are thought to facilitate the acquisition of these abilities. One component of this effort is the requirement that each student assemble at least one molecular model on each quiz after they learn to predict the geometric shape of molecules. This not only ensures constant review of some of the most abstract of the conceptualizations, but also makes it possible for the student to begin to develop the very necessary skill of visualizing in three dimensions.

7. Optional Modules for the Acquisition of Learning and Study Skills. Adoption of a PSI format with required mastery of chemistry content furnishes a reliable mechanism for ensuring high-level mastery of chemistry content. This, in turn, has made it possible to devote additional effort to the development of more general learning and study skills *within* the general chemistry sequence itself. Thus, for instance, optional bonus points are frequently offered for outstanding performance on unannounced activities designed to test notetaking skills, problem-solving skills, ability to write good definitions, etc. Students who perform at the acceptable level receive bonus points immediately. The other students are strongly encouraged to participate in scheduled remediation which, upon completion, earns the same number of points. These bonus points may be used, within limits, to raise the student's final grade in the course. This is sufficient to get the students interested in completing the first two or three such activities after which the intrinsic reward of "making points" provides sufficient motivation to encourage a large majority of the class to continue completing them.

8. Special Effort Directed Toward Building Self-Confidence. Students are required to score 90% correct in order to pass each module quiz. The fact that this criterion can be employed, even though many students are educationally disadvantaged, speaks well for the use of the modified PSI format. Furthermore, observations and interviews indicate that the positive experience of attaining "A" level performance on a demanding test has a profound effect on the students' self-esteem and their confidence in their ability to succeed academically. Both faculty and learning assistants lavish praise freely for good performance, especially at the beginning of the course when students are likely to be unsure of their abilities.

9. Final Exams Demand High Level of Performance but are Repeatable. It would ultimately be self-defeating to expect less performance from educationally disadvantaged students than from their better prepared classmates since they will be expected to have the same preparation in advanced courses. At the same time, it is important that maintaining high expectations be coupled with mechanisms which allow disadvantaged students to attain success. At Xavier, the course grade in general chemistry is determined primarily by performance on an objective final examination. This anticipates the necessity to perform well on the type of standardized exams encountered in entering many science-related fields. Educationally disadvantaged students often perform poorly on such examinations. It appears that this is mainly due to a) no real idea how much time and effort is necessary to be really prepared for an exam and b) a lack of test-taking skills. In order to maximize the number of students who reach the expected level of performance in general chemistry at Xavier, the course offers the opportunity to take a final, obtain immediate scoring, schedule restudy and tutoring using the actual exam just completed, and subsequently take a different version of the final examination. This procedure not only makes it possible for the students to learn what it really means to be prepared for an examination but also provides a means for systematically analyzing why a student performs poorly on standardized examinations. Thus, it not only increases the course's major product — amount of chemistry learned by the students — but also increases their general test-taking skills.

10. Special Grading System Provides More Time if Needed. General chemistry at Xavier employs a special grading system which discourages procrastination, yet accommodates those students who require more than one semester to adequately master the content of a course. If a student has not completed all course requirements by the end of the semester but has made reasonable progress, he or she may receive a grade of DC (Deferred Credit) which allows the student to continue with the remaining modules the following semester. While effecting the same benefits as a prep course (an extra semester in the course) this mechanism seems preferable since the placement of a student is made on the basis of his or her actual performance rather than on a prejudgment on the part of the faculty. In order to make it possible for Xavier to afford such an option, students pay regular tuition charges when re-enrolling in the course and the student is counted into the faculty teaching load in the usual manner.

11. Extensive Out-of-Class Tutoring Offered. In addition to the cognitive therapy tutoring offered during drill sessions, the Chemistry Department also offers extensive opportunity to receive tutoring out of class. The tutorial service is staffed by advanced students, faculty, and a part-time staff person for approximately 20 hours per week, about one-third of which is scheduled after five o'clock p.m.

12. Piagetian-based Laboratory Sequence. In an effort to further increase the probability that all students in the course develop the analytical reasoning skills needed to successfully complete a degree in a science-related curriculum, a set of Piagetian-based "learning cycles" (Karplus, 1974) have been developed at Xavier for use in the general chemistry laboratory sequence. These materials are available in the *Laboratory Manual*. Each laboratory experiment is designed to introduce abstract concepts by collection and analysis of data collected in the laboratory. The experiments are presented in a sequence which generally ensures that the concrete experience in the laboratory precedes the formal consideration of the concept in the lecture. As noted previously, every effort is then made to begin lecture presentations with a "concrete" example related to the laboratory experiment.

Student Evaluation and Performance

The decision to modify teaching techniques in the general chemistry sequence for science majors at Xavier in an effort to assist the educationally disadvantaged has been extremely successful.

1. The average performance of students completing general chemistry at the University has increased more than twenty percentile points on a standard measure of achievement, the American Chemical Society's *Cooperative Examination in General Chemistry*. Further, the average performance on this test is now above the national average (including opportunities to repeat with no review of tests) — a remarkable

achievement considering the average SAT/ACT scores of students entering Xavier.

2. The percentage of students completing the two semester sequence has increased from 50% before the modification initiated in the latest phase of development to more than 65% at present.
3. Students in general chemistry have consistently rated the course highly in a University-wide course evaluation procedure. In addition, a departmentally-administered questionnaire indicated that 83% of the students *liked* general chemistry even though they felt they worked harder in the present course than they would have in a traditional one. The compensating factor was apparently the fact that they felt they also learned more than they would have in a traditional course.

Conclusion

Xavier's general institutional philosophy of "standards with sympathy" has been translated into a general chemistry sequence which maintains high requirements for completion while supporting a number of teaching techniques designed to assist the student to reach the expected level of performance. These techniques, arrived at in an empirical fashion, have made the course more accessible to the educationally disadvantaged and, as a result, have both increased performance in and reduced attrition from the sequence. The other science departments at Xavier are also expanding their efforts to find new teaching techniques with special emphasis on nurturing analytical reasoning. Studies at other institutions (Peleg and Adler, 1977; Sadler, 1979) suggest that student performance in chemistry may improve still further as other freshman courses incorporate similar approaches especially in the area of using cognitive therapy and Piaget-an-based materials to teach general problem-solving and learning skills.

NOTE: This program is made possible in part by a RUTE Grant and a CAUSE Grant from the National Science Foundation.

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Appendix XXV

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Donald Robinson
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A Piagetian-Based General Chemistry Laboratory Program for Science Majors

In recent years, considerable attention has been given to Piaget's theory of intellectual development and its implications for science teaching. Of particular interest is the possibility that the theory provides a basis for formulating instructional strategies which would encourage the development of problem-solving ability (Piaget's formal operational level) and consequently make the sciences more accessible to the educationally-disadvantaged. An excellent resource paper which reviews the literature concerning these, and related, topics has appeared in *this Journal* recently (*1*).

As one part of an effort to explore new methods of increasing performance in and/or decreasing attrition from entry level science courses, in 1976 the science departments at Xavier (a small, historically-black institution in New Orleans) initiated a cooperative program to develop and field-test Piagetian-based materials. That effort led to the development of twenty-five laboratory exercises (five each from Biology, Chemistry, Computer Science, Mathematics, and Physics), each organized as a "learning cycle" (*2*). Subsequent field-testing of these exercises for three years in a pre-freshman summer program for science majors (Project SOAR—Stress On Analytical Reasoning) has indicated that their use produces statistically significant improvement in SOAR participants' ability to complete correctly activities believed to measure reasoning ability (*3–5*). It is hoped, but not yet possible to prove, that this improvement is accompanied by a corresponding increase in ability to perform in entry-level science courses.

Recognizing that a six-week summer program, no matter how intensive, could not remedy all deficiencies (even if all entering science majors could afford to attend), in 1976 the chemistry department at Xavier also began formulating laboratory experiments similar to those in SOAR for use in its general chemistry laboratory sequence for science majors. The first stage of this effort, spurred on by the apparent success of SOAR, has now been completed. A full, two-semester sequence of experiments in the learning cycle format has been developed and has been in use in the general chemistry laboratory program at the University since the fall of 1978. This paper discusses various aspects of the new program for the purpose of sharing ideas concerning methods of applying Piaget's concepts within the traditional instructional framework and stimulating discussion of the problems which arise when attempting to do so in a course for science majors.

An Overview of the General Chemistry Laboratory Program at XU

The general chemistry laboratory program at Xavier consists of two semesters of weekly, 3-hr laboratory periods conducted by full-time faculty. Each laboratory class enrolls approximately 24 students each semester, almost all of whom are science majors who expect to complete two years of chemistry in addition to the general chemistry course. Students receive one-semester hour credit for completing each of the two laboratory courses while concurrently enrolled in corresponding, separate three-semester-hour lecture courses.

Until recently the general chemistry laboratory experiments at Xavier were traditional, content-oriented exercises which stressed skills and verification of chemical principles with detailed explanation and instruction at every step. This approach appeared to be very good for teaching laboratory skills and was effective, for many students, in teaching/reinforcing a variety of chemical principles and calculations of value. However, because traditional experiments primarily required verification of ideas which had already been spelled out in detail at the outset of the experiment, they provided little opportunity for the educationally-disadvantaged student to gain experience in "doing science" or to develop the ability needed to analyze data (or solve problems) of a general nature. Therefore, because the success of SOAR indicates that experiments in the "learning cycle" format potentially enable educationally-disadvantaged students to overcome deficiencies, the chemistry department chose to initiate its current laboratory program—a full, two-semester sequence of "learning cycles."

Generally, laboratory experiments in the learning cycle format place more emphasis on learning by doing than is the case for traditional verification experiments. Each learning cycle consists of three phases: *exploration*, *invention*, and *application* (discovery). The phases, and what occurs in each during a laboratory period at Xavier, are described briefly below.

In the first of these phases, exploration, the student is allowed to interact with concrete materials to acquire information about a given chemical or physical system with a minimum of guidance. The student is given only a brief introduction to needed laboratory skills, a review of safety precautions, and such general guidelines as are necessary to establish sufficient limits to ensure that the experiment can be completed during a 3-hr laboratory period. *NO* theoretical introduction is given and the student is *not* given any prior information about what relationships to seek. Whenever practical, individual students (or groups of them) are allowed to determine pertinent variables for the system. The instructor seldom attempts to eliminate extraneous factors (and often *purposely* introduces them), and students are allowed to make non-dangerous mistakes without interference. The student would normally complete this activity by the midpoint in the laboratory period. If this is not enough time to collect the amount of data needed for the desired analysis, an individual's data would be pooled with that from "another laboratory section" (carefully selected by the instructor) or with that from classmates.

In the second phase, invention, the student is asked to analyze the data gathered during exploration. As appropriate, analysis might include seeking relationships between variables, making generalizations from these relationships, constructing graphic presentations, and developing an empirical equation which describes the relationship mathematically. As in the previous phase, the instructor does not tell the student merely to verify a known answer but rather asks questions which guide the student to develop a logical analysis of the data. In so doing, the instructor does not discourage investigation of chemically unimportant relationships (such as the relationship between height and volume of a cylinder in an experiment designed to emphasize density) but instead encourages *further* investigation to see what other relationships might exist. Students are actively encouraged to work in pairs (or larger groups) in the invention phase. In addition, the phase is usually initiated by a short, instructor-led pre-

[1] Author to whom inquiries should be directed.

liminary discussion of the data which is intended to suggest possible considerations rather than to provide specific answers. The above description should not be read to imply that a student is expected to "invent" all of modern chemistry in detail. Instead, the laboratory program focuses on acquisition of concepts of a general nature as a basis for more detailed study in the corresponding lecture.

In the final phase, application, the student extends the basic concepts from invention in some manner. This stage might include making predictions based on concepts developed, conducting student-designed experiments which test the prediction, or (occasionally) using self-designed experiments to investigate an area closely related to one studied previously.

The general chemistry laboratory handouts at Xavier resemble a workbook in that they require the student to answer questions in writing as they proceed through the experiment. This process not only requires that the student think about the data while working, but also it provides an opportunity for the instructor to interact with individuals as they attempt to answer the questions. Students are generally urged to complete the invention section, and as much of the application section as possible, while in the laboratory so that they can receive assistance (in the form of leading questions) as needed. Thus, although most students have some remaining questions or problems to complete on their own, the majority of the required report is finished before leaving the laboratory. This approach has proven to be particularly successful for students who have weak backgrounds, since they can receive assistance in analyzing the quanitative data. Such assistance, of course, becomes more difficult to obtain as the semester proceeds and the students acquire more experience.

Table 1. Synopses of Selected Learning Cycles

Mass and Volume Relationships	
Exploration:	Measure mass, volume (by displacement of water), length, and diameter of brass and aluminum cylinders.
Invention:	(a) Look for general relationships among variables. (b) Plot mass versus volume for aluminum cylinders to see what type of relationships might exist. Develop an equation relating mass and volume, first by trial and error, then by determining slope and y-intercept and placing in the general equation for a straight line. (c) Plot mass versus volume for brass and perform the same type of analysis as for aluminum. (d) The concept of density is introduced.
Application:	(a) Use both the graphs and equations developed in "invention" to predict either masses or volumes of aluminum or brass given the value for one of the variables. (b) Calculate volumes of metal cylinders from equation $V = \pi r^2 h$, compare values with those obtained by water displacement, and discuss possible reasons for differences noted.
Classification of Chemical Substances by Physical Properties	
Exploration:	For eight solids determine approximate melting points; solubilities in water, polar organic, and non-polar organic solvents; conductivity in solid phase and in water solution (instructor provided conductivity in molten state); and density for one substance (others supplied by instructor).
Invention:	(a) Classify the substances separately on the basis of similarities in melting point, solubility, conductivity, and density. (b) Develop a general classification scheme which groups substances with similar properties in all categories. (These classifications form the basis for later discussion of the relationship between physical properties and bonding type in lecture.)
Application:	Design a brief experiment to extend your knowledge of the physical properties of substances in some manner. Sample possibilities are "Does solubility of a substance in water depend in any way on the temperature of the water?" and "Does the conductivity of a substance dissolved in water depend on the quantity of the substance dissolved?"
Colorimetry	
Exploration:	(a) Observe solutions of various colored salts and compare two solutions of a salt, one dilute and one concentrated, to note the difference in color intensity. (b) Prepare six solutions of different concentrations by dilution of a stock solution of a colored salt. Place equal volumes of each solution into tubes of large diameter and small diameter. Rank solutions according to color intensity.
Invention:	Look for relationships between color intensity and other variables.
Application:	(a) Use "standards" prepared in the exploration phase to determine visually the approximate concentration of an unknown solution of the same salt. Determine from relationships found in the invention phase what conditions are necessary for a fair comparison of unknown and standards. (b) Determine the concentration of an unknown using a spectrometer after the operation of a spectrometer is explained briefly.

A synopsis of three typical laboratory experiments from the general chemistry laboratory program at Xavier is provided in Table 1. It should be noted that although their format is non-traditional, the content of each is typical of that in other general chemistry laboratory programs. A list of the entire sequence of experiments is given in Table 2 to indicate the range of topics covered.

Some Specific Noteworthy Characteristics of the Program

The following specific characteristics of the program are sufficiently different from that in a traditional laboratory program to warrant additional consideration.

Laboratory Precedes Lecture

Most general chemistry programs attempt to coordinate lecture and laboratory so that lecture precedes laboratory. *The program at Xavier attempts to do exactly the opposite —to schedule laboratory experiments before corresponding lectures.* This approach, according to the implications of Piaget's theory, maximizes the chances that the educationally-disadvantaged will understand since it introduces concepts via concrete experience in the laboratory. Furthermore, there is some evidence that this approach also benefits those who are already capable of abstract (Piaget's formal operation) thought (6). The relationship between real, concrete experience and theoretical concepts is further enhanced by beginning consideration of a particular topic in lecture with a rapid, group analysis of data similar to that previously collected in the laboratory.

Process, as Well as Content, Has Its Place

Each laboratory exercise at Xavier represents a compromise between the need to allow sufficient time for the academically

Table 2. List of Laboratory Experiments in General Chemistry

1. Introduction to the Chemistry Laboratory*
2. Basic Laboratory Techniques*
3. Mass and Volume Relationships
4. Classification on the Basis of Physical Properties
5. Chemical Periodicity
6. Mass Relationships in Chemical Relations
7. Chemical Formulas
8. Behavior of Gases
9. Heat Relationships
10. Colorimetry
11. Paper Chromatography
12. Volumetric Equipment and Preparation of Solutions
13. Solubility
14. The Freezing Point of A Solution
15. Equilibrium
16. Acids and Bases I
17. Acids and Bases II
18. Electrochemistry
19. Cation Identification
20. A Study of the Rate of a Chemical Reaction

* Not Piagetian-based.

weaker students to think through a logical analysis and the need to cover the amount of content (and skills) required for upper level chemistry courses. A typical laboratory experiment at XU is therefore generally more open-ended and less detailed in content orientation than are traditional experiments while, at the same time, more content-oriented and less open than are most "inquiry" laboratories. The degree of success in reaching a good compromise varies considerably from topic to topic. This problem, also formulated as that of finding the best way of casting a given item of standard laboratory content into a learning cycle format, continues to require that considerable effort be devoted to further refinement of the materials in use at XU.

Social Interaction is a MUST

The opportunity for the student to discuss ideas, social interaction, has been identified by Piaget as one of the components necessary for developing intellectually. In order to encourage such interaction, several procedures have been adopted at Xavier. First, all students are required to work with partners in each experiment. Second, several experiments require that the entire class do some advance planning since no one pair can collect all of the data needed and the instructor does not assign a particular pair of students to collect a particular set of data to pool. Third, in most experiments, the instructor initiates a group discussion at the beginning of the "invention" phase and continues to serve as devil's advocate in subsequent, systematic interaction with each pair of students. Conflicting views which appear in the course of analyzing the data provide an opportunity for the students to consider how these conflicts might have arisen and how they might be resolved.

Grading is VERY Difficult

It is usually more time-consuming to grade reports from learning-cycle laboratory experiments than it would be to grade those from traditional verification experiments because considerably more judgment is required to assess degree of consistency between data and conclusions (as seems appropriate for learning cycles) than between empirical and theoretical results (as is typical for verification experiments). A student's course grade in the program at Xavier is determined by a combination of grades from individual experiments and the grade from a closed-book final which requires analysis similar to that used during the semester. Therefore, the laboratory final, like the experiments, is more process-oriented than would be a traditional laboratory final.

Evaluation

Unlike participation in Project SOAR which takes place over a relatively short period of time with no intervening activities which are likely to affect student performance, completing the general chemistry laboratory program is not an isolated event whose effect can be measured separately from that of other activities. Therefore, it has not been possible to evaluate the general chemistry laboratory program at XU in the same clean-cut manner used for SOAR. The evaluation problem is particularly compounded by the fact that there are a number of features of general chemistry lecture, in addition to those mentioned in this paper, which are also devoted to developing the same type of basic problem-solving skills (7, 8). Instead, the success of the program, and the reasons for retaining and further refining it, can be determined only by the indirect measures indicated below.

1) As noted previously, the use of similar materials in Project SOAR had the desired effect of increasing reasoning ability (3, 4, 5). It is therefore reasonable to assume that the use of similar materials in general chemistry laboratory will have a similar effect.

2) In spite of the difficulty of isolating the effect of laboratory from other factors when it is only one part of the student's academic experience during an academic year, in 1977 a pilot study was undertaken [illegible] the first draft of the Piagetian-based experime[illegible] to provide guidance in further development of [illegible]am. This pilot study compared the performance [illegible]esson Chemistry 101 laboratory sections, one [illegible]al materials and one using the first draft of [illegible]cles. That study, admittedly contaminated [illegible]l factors and limited to small numbers of st[illegible]ed that

> Both sections [illegible] on a Piagetian-like instrument (9) at the end of the semester than at the beginning *but* that the average gain per student was almost twice as high in the section using learning cycles as in that using traditional laboratory experiments. The two sections had performed equally well at the beginning of the semester. (The ACT-SAT and high school grade point averages of the two were also approximately equal.)
>
> Attendance in the experimental group was markedly better than in the traditional one. There were only three absences during the semester in the experimental section, whereas the traditional section had seventeen (about the same as other traditional sections).
>
> The students in the two laboratory sections performed equally well on a "skills-oriented" laboratory practical administered as one part of the final in the two courses.
>
> Student evaluation of the experimental laboratory program (in a university-wide evaluation) was decidely better for the Piagetian-based laboratories than for traditional ones. Ratings for the experimental group were uniformly positive and there were a number of glowing comments about the program whereas all traditional sections, including the one used for comparison, received the usual mediocre ratings with little or no praise.

This one-semester pilot study, while not conclusive, was sufficiently encouraging to provide incentive to develop the remainder of the program. Unfortunately, limited staff made it impossible to continue to conduct two separate types of laboratory programs, especially while attempting to develop/refine one of them. Therefore, in order to ensure that sufficient time was available to do the best possible job in developing the present program, all sections of general chemistry laboratory have used the learning cycle materials since the fall of 1978. The decision to change completely to the new program was made only after noting that all available evidence suggests that both low *and* high ability students would benefit.

3) Subsequent classes of general chemistry students have continued to show improvement in ability to perform on the Piagetian-like test from beginning to end of the program and to give the program high evaluations. It is not possible to compare attendance records before and after the fall of 1978 because the university began requiring attendance in all freshman-level courses at that time.

4) Sixty-five percent of the freshmen in Chemistry 101 in the fall of 1979 were able to analyze correctly a set of typical data (using only x and y to specify variables) at the end of the course. While there is no comparable data for a traditional course, it is the belief of instructors who have taught both types of course that it would have been much lower.

Conclusion

Over the past three years, the Chemistry Department at Xavier University of Louisiana has developed and field-tested a set of Piagetian-based learning cycles for general chemistry laboratory. While there is no direct, definite proof that the new materials are accomplishing the intended goal of improving students' ability to solve problems (and consequently reducing attrition from and increasing performance in general chemistry and subsequent science courses), there are numerous indirect measures which indicate that they have the possibility of doing so. Therefore, additional refinement of materials and ongoing evaluation of the program is now in progress. This paper is designed primarily to provide information about the development of the program at Xavier in the hope that other faculty who are investigating the use of similar instructional strategies will share ideas, thus mutually facilitating development and evaluation of Piagetian-based programs.

Acknowledgment

Acknowledgment is gratefully given to the National Science Foundation for RULE Grant SER76-14237 and CAUSE Grant SER77-06227 which provided the major portion of the financial support to develop the Piagetian-based general chemistry laboratory program at Xavier.

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Appendix XXVI

Project SOAR (Stress On Analytical Reasoning)

J W Carmichael, Johnette Hassell, Jacqueline Hunter, Lester Jones, Mary Ann Ryan, and Harold Vincent

IN RECENT YEARS, there has been considerable interest in Piaget's theory of intellectual development and its implications for teaching science in high school and college (Renner and Lawson 1973; Lawson 1975; Beistel 1975, Piaget 1973). This article describes a Piagetian-based summer program, Project SOAR (Stress On Analytical Reasoning), for natural, health and mathematical science majors. The program was jointly developed and is conducted by the Departments of Biology, Chemistry, Computer Science, Mathematics, and Physics at Xavier University of Louisiana. Its overall goal is to increase performance in and reduce attrition from science and mathematics courses and consequently to increase the number of qualified graduates in these areas. The program is a direct outgrowth of the University's primary institutional goal to provide educational opportunities to black Americans. Xavier University of Louisiana is a small, predominantly black institution located in the approximate geographic center of the city of New Orleans. In 1978-79, 85% of the total enrollment of approximately 1,600 was black, and more than 40% of the students were a natural, mathematical, or health science majors.

Piaget's Theory and Its Implications

According to Piaget's theory, individuals progress through definite stages of intellectual development and are limited in what they are capable of comprehending while in each stage. Only upon reaching the highest level of development, the formal operational stage, does an individual acquire the ability to reason with concepts, relationships, abstract properties and generally to use thinking processes in situations where one does not deal with tangible objects. The importance of this theory to those interested in mathematics and science education becomes evident when one considers that as much as 50% of the college freshmen in the United States can only function at the concrete operational level (McKinnon and Renner 1971; Kolodiy 1975) and that much of the content of mathematics and science requires, by its very nature, formal reasoning (Herron 1975; Bauman 1976). Piaget's theory, then, makes it possible to better understand what is meant by the common complaint (of faculty) that many students lack problem-solving skills.

Further, according to Piaget, learning occurs, not upon the individual's being told of the detailed implications of an idea, but rather as the individual *actively* analyzes a problem situation, considers tentative solutions, evaluates their effectiveness, and then tries new approaches when the first ones are not successful. It thus appears that science and mathematics instruction would better serve students who lack problem-solving skills if organized so as to confront students with concrete problems and meaningful inquiries *before* moving to abstract ideas. Furthermore, since Piaget also suggests that individuals capable of formal thought revert to concrete operational reasoning when encountering new material, it would appear that even the formal thinkers (supposedly those successfully completing the courses) would also benefit from such an approach. One study has verified this conclusion (Sheehan 1970).

A particularly promising format suggested for use in teaching to promote intellectual development is the three-part "learning cycle" consisting of exploration, invention, and application (Karplus 1974). In the exploration phase, the student is allowed to interact with physical materials with a minimum of guidance so that new information can be acquired that does not fit the existing mental framework. The student is not told exactly what to look for, but rather is asked to investigate a particular problem in an open manner. In the invention phase, the student attempts to analyze the data gathered in the previous phase. The instructor encourages the student to organize the data, to form hypotheses, and to look for inconsistencies, thus providing an opportunity for the student to build, destroy, and rebuild reasoning patterns. In the application phase, further experimentation and analysis

This article was written by the members of the Project SOAR staff, Xavier University, New Orleans, Louisiana 70125. Staff members included: J W Carmichael, professor, Chemistry Department; Johnette Hassell, associate professor, Computer Science; Jacqueline Hunter, assistant professor, Biology Department; Lester Jones, assistant professor, Mathematics Department; Mary Ann Ryan, assistant professor, Chemistry Department; and Harold Vincent, associate professor, Physics Department.

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TABLE 1. List and Short Description of Learning Cycles from Project SOAR

Discipline	*Short Description of Learning Cycles*
Week 1: Control of Variables	
Biology	Environmental factors which determine opercula movement in goldfish.
Chemistry	Variables which determine the rate of the iodine clock reaction.
Computer Science	Factors which determine survival in a computer simulation.
Mathematics	Control of numerator and denominator for comparison of fractions.
Physics	Study of two systems which exhibit periodic motion.
Week 2: Proportional Reasoning	
Biology	Proportional representation of geological eras.
Chemistry	Relationship between amount of reactant & product if Mg is burned.
Computer Science	Relationship between the length of shadow and the height of objects.
Mathematics	Construction of paper triangles to yield trigonometric ratios.
Physics	Study of force required to move objects of varying masses.
Week 3: Combinatorial Reasoning	
Biology	Effect of simulated Martian environment on pillbugs.
Chemistry	Identification of chemicals with missing labels.
Computer Science	Learning to flowchart through permutation of steps.
Mathematics	Study of numbers of geometric figures obtainable on a pegboard.
Physics	Combinations of switches which will ring a bell.
Week 4: Probability	
Biology	Knives, forks, and spoons to simulate chromosomes in meiosis.
Chemistry	Sampling as a means of estimating the number of beads in a jar.
Computer Science	"Craps" played on an interactive computer terminal.
Mathematics	Loaded dice yield probability as a prediction number.
Physics	Octahedral and cuboctahedral dice simulate radioactive decay.
Week 5: Recognizing Correlations	
Biology	Effect of hormones on physical characteristics of Euglenae.
Chemistry	Concentration versus length of time to react.
Computer Science	Simulation of battles investigating variables pertinent for victory.
Mathematics	Graphing of scattergrams and determining strength of linearity.
Physics	Relationships between variables in simple DC circuits.

are used to reinforce, refine, and enlarge the understanding of the concept that helps to stabilize the newly modified mental framework. The entire process might be termed a "concrete approach" because it introduces concepts at a concrete level before considering abstract relationships.

This article describes one part of a major project to determine if a coordinated, multidisciplinary "concrete approach" will reduce attrition from entry-level science and mathematics courses. Chiappetta (1976) has recently provided a review of related studies. Of particular interest are two previous pilot studies organized totally in a Piagetian-based fashion, one a summer program (McKinnon 1976) and the other an academic year project (Tomlinson-Keasey and Eisert 1978). These projects differ markedly from Project SOAR, however, in that neither directly emphasized specific components of problem solving.

Description of Project SOAR

Project SOAR strives to enhance the problem-solving ability of pre-freshmen indicating an interest in mathematical, natural, or health sciences when "problem-solving ability" is assumed to be intimately related to ability to function at the formal operational level. Further, Project SOAR is the first phase of a projected program that will introduce Piagetian components into entry-level mathematics and science courses for majors in the involved disciplines. When completed, the total program will encompass approximately one-half of the course load of science and mathematics majors during the first two years at the University. Contemplated development is intended to supplement, not replace, existing tutorial and developmental programs. The present investigation assesses the interim progress of the program.

The core of Project SOAR consists of twenty-five, three-hour laboratory experiments (five from each of the participating disciplines) that stress five of the major components of problem-solving: control of variables, proportional reasoning, probabilistic reasoning, combinatorial reasoning, and recognizing correlations. Each experiment presents a real problem from one of the disciplines and requires the use of the desired component of problem solving to obtain a reasonable solution. The concepts in each experiment complement the content of the corresponding entry-level course. The author of each experiment organized it into the learning cycle format and modified it until the rest of the authors of this paper agreed that it was suitable with respect to format, ability

to complement entry level courses, ability to encourage use of the desired component of problem-solving, and ability to generate student interest.

Each week of the five-week program, the participants in Project SOAR were randomly divided into five groups. Each group completed one experiment per morning. By the end of the week the groups had completed five laboratory experiences intended to develop the given mental structure for that week, but in a different sequence. Faculty members were assigned to the various laboratory sessions so as to maintain a student/faculty ratio of approximately 7:1. Prior to the program all faculty members completed a training program in Piagetian-based science teaching using readily available materials (Karplus 1977). Because of the low student/faculty ratio and the three hour time period for each laboratory, it was possible to give each student as much individual attention as was desired each day. Laboratory activities were carefully designed to encourage the student to collect data, examine them, form hypotheses, test these ideas, discuss them with peers, seek inconsistencies, make projections, etc. Care was also taken to ensure that the students understood that the object of each experiment was to obtain an answer logically consistent with the data collected, not an accepted, "correct" one. Thus, most student inquiries directed to instructors elicited questions designed to encourage further thought rather than direct answers. The instructor generally collected written work, examined it, and returned it to the student with encouraging comments or open-ended questions placed on the papers. No traditional grades were assigned. A short description of each of the problem-solving activities is given in table 1.

In the afternoon SOAR students engaged in activities designed to improve vocabulary, note-taking ability, and ability to visualize in three dimensions. To increase motivation, the program coordinated with the academic endeavors a series of social functions, tours of local scientific facilities, and presentations by various scientists and mathematicians.

There were 57 students in Project SOAR in 1977 and 109 in 1978. All had graduated from high school immediately before enrolling in the program and were expecting to enter college in the fall. We solicited the participants by publicity in local media, brochures mailed to high schools, and information sent to science and mathematics applicants to XU. Selection was by the "warm body" process; that is, we accepted into the program both years all who completed the short SOAR application and submitted an application to Xavier (for the fall) indicating an interest in mathematics or science. Each year more than 90% actually matriculated at the University as science majors. The program is further described in the Sixth Report on Teaching (Lincoln 1978).

Evaluation Instrument

The classroom test of formal reasoning developed by

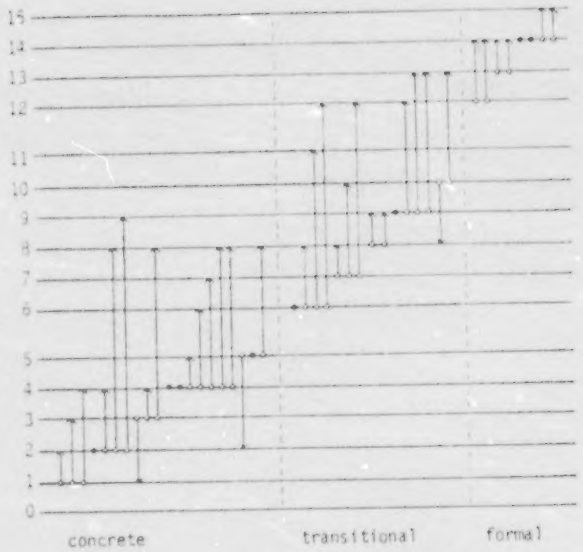

FIGURE 1 Pictorial representation of performance on pre- and post-tests by students in Project SOAR in 1977

Lawson (1978) functioned as a pre- and post-test to SOAR participants in both 1977 and 1978. Lawson designed this instrument for group administration and to strike a balance between time-consuming individual interviews and easily misinterpreted pen-and-paper tests. Moreover, Lawson validated the test for eighth, ninth, and tenth grade students ranging from thirteen to eighteen years old. It consists of fifteen items each of which begins with the instructor demonstrating a physical situation about which the student may ask questions freely. The instructor then poses a question about some aspect of the demonstration and each student responds individually by choosing the correct multiple-choice answer and explaining in detail how the answer was obtained in an individual test booklet. Answers are correct only if both portions are acceptable. Lawson's validation procedures indicate that scores of five or fewer correct items represent concrete reasoning, six to eleven correspond to a transitional level (between concrete and formal), and twelve or more correct is expected for an individual at the formal operational level. The instrument requires approximately ninety minutes to administer.

In 1977 all SOAR participants took Lawson's test *via* demonstrations in one group setting. In 1978 they watched the demonstrations *via* video in four separate groups of equal size. A SOAR instructor was present with each group to explain the video demonstration further and supervise administration of the instrument.

Because the same instrument served for both pre- and post-tests, instructors were careful to ensure that test items were discussed only during the administration of the exam and that activities in SOAR did not duplicate test items. Moreover, unlike interviews in which the student receives feedback, Lawson's construction of the test provides no opportunity to learn from the test experience. In spite of these precautions and the time lapse of six weeks between administrations of the pre- and post-

tests, we undertook a test-retest reliability study with eighteen non-SOAR freshmen science majors. The number of students involved in the study was small, but the results showed a high Spearman Rank correlation coefficient of 0.91 with an average change of +0.4 points. Therefore, we believe that significant improvement due solely to retesting was unlikely.

At least two of the authors evaluated each individual test item without prior knowledge of name of student or when the item was administered. Subsequent comparisons of these evaluations indicated discrepancies less than 10% of the time. The authors discussed the discrepancies as a group without consideration of name or date of testing, until a consensus evaluation was reached. Afterward, Lawson evaluated the thirty exams from 1977 that had had the largest number of discrepancies when evaluated at XU without knowing that they had been problem cases or when they had been administered. His evaluation agreed with that of the XU evaluators on 430 of the 450 items. The high degree of consistency between the two independent evaluations suggests that the XU evaluation is valid. Therefore, in 1978 all evaluation was conducted locally using the same procedure as in 1977.

Results

Figure 1 presents the raw data from pre- and post-tests for 1977; figure 2 presents the data for 1978. Each arrow represents an individual student. The tail of the arrow indicates the number of items the student answered correctly on the pre-test and the head indicates the number s/he answered correctly on the post-test. The solid dots indicate individuals whose scores were the same on both tests. The results for concrete, transitional, and formal participants (measured at the beginning of the program) are grouped so as to facilitate consideration of the effect of the program on each.

Approximately three-fourths of the students in both summers obtained higher scores at the end of the program than they did at the beginning. Statistical consideration of the data in figures 1 and 2 *via* a Wilcoxon Matched Pairs Signed Rank Test (Senter 1969) is on the first line of table 2. A statistically significant difference exists between performances on pre- and post-tests for both the 1977 group and the 1978 group. Similar statistical analysis of the data for the three traditional grouping levels (as determined by the pre-test scores) appears in table 2. This analysis indicates that in both years concrete and transitional students made significant gains in their scores, but individuals classified as formal on the pre-test did not show a statistically significant change.

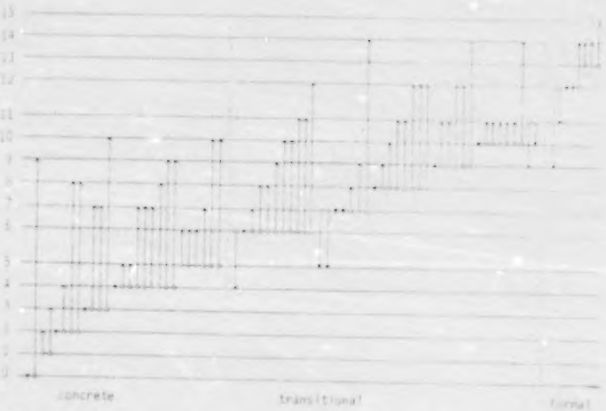

FIGURE 2. Pictorial representation of performance on pre- and post-tests by students in Project SOAR in 1978.

In view of the obvious effects of topping-out on the test and the small numbers of students who began at the formal level, it is not surprising that no statistically significant improvement is noted for this group. However, it would appear qualitatively that the achievements of the majority of the formal operational students were, at least, not impaired by participating in the program.

Conclusions

Project SOAR is only the first phase of a proposed program whose overall goal is to reduce attrition from and improve performance in entry-level mathematics and science courses by the introduction of Piagetian-based learning cycles into these courses. Because the majority of the program is not yet in operation, evaluating the entire program on the basis of its ultimate goal at present is not possible. Further, great care should be taken in generalizing from this interim study, as all SOAR participants were minority pre-freshmen interested in majoring in mathematics or science and were thus unlikely to be representative of the college populace as a whole. How-

TABLE 2. Analysis of Performance of SOAR Participants for 1977 and 1978

	1977			1978		
Beginning Level	*Wilcoxson T*	*N*	*p*	*Wilcoxson T*	*N*	*p*
Combined	51	35	< 0.01	158	64	< 0.01
Concrete	15	16	< 0.01	0	23	< 0.01
Transitional	45	13	< 0.01	63	35	< 0.01
Formal	0	6	*	8	6	*

*Not significant

ever, despite these limitations, three tentative conclusions emerge from the investigation.

1. The proportion of non-formal students in SOAR agrees with the hypothesis that at least half of the college freshmen in the United States are not able to operate at the formal operational level.

2. An intensive pre-college summer session based on the use of physical materials in a learning cycle format and focusing on specific components of reasoning can significantly improve intellectual development as measured by Lawson's test of formal operations.

3. Participation in a summer program such as SOAR could potentially increase the intellectual development of students at all levels of development. This is consistent with previous findings that a concrete approach benefits students at all levels.

In summary, the present study shows that students' level of intellectual development should be a concern of mathematics and science teachers. Further, it implies it is possible to enhance students' problem-solving abilities using a learning cycle approach to mathematics and science instruction. Additional experimentation at both the high school and college level is certainly warranted.

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Appendix XXVII

Teaching critical reading and analytical reasoning in Project SOAR

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All of the authors teach at Xavier University of Louisiana, New Orleans. Whimbey is with the department of special services/reading, Carmichael with the department of chemistry, Jones in mathematics, Hunter in biology, and Vincent in physics. *Funding for this project was provided by the William R. Kenan, Jr., Charitable Trust and by Title III Grant #GOO-75-01678.*

A number of educators have noted the close relationship between critical reading and analytical reasoning. As early as 1917, Thorndike titled a paper "Reading as Reasoning: A Study of Mistakes in Paragraph Reading." More recently, Holmes (1967) statistically analyzed a battery of reading tests and concluded that reading is a "verbal-processing skill of symbolic reasoning" (p. 19). Farr (1971) pointed out that from the very first reading test (the Kansas Silent Reading Test, 1916) through current instruments like the California Achievement Test, questions appearing in tests of reading comprehension bear a strong similarity to questions on standard verbal intelligence tests. This article describes a successful precollege summer program, Project SOAR (Stress On Analytical Reasoning), which uses "cognitive process instruction," a method of teaching comprehension and analytical skills that emphasizes the connection between the two. Students who completed just five weeks of SOAR showed statistically significant gains on both a standardized reading test and the Preliminary Scholastic Aptitude Test (PSAT).

Project SOAR—An overview

Project SOAR is a five-week summer program (with an additional week for pre and posttesting) at Xavier University of Louisiana, a small, predominantly Black institution in New Orleans. The program is conducted as a joint project by the departments of biology, chemistry, mathematics and computer science, and physics. It is specifically designed to enhance the problem-solving and academic abilities of pre-freshmen entering the University with an interest in the natural, health, or mathematical sciences. The program carries no academic credit but is available, at no cost for tuition, to all science students accepted at the university. In 1979, approximately one-half of the entering science freshmen, 113 students, completed the program. To facilitate the instructional process, participants were divided randomly into five groups of approximately equal size.

Project SOAR has two components: (1) Piagetian-based laboratory exercises from 9 a.m. to noon and (2) cognitive process instruction (problem-solving/comprehension classes) and vocabulary building from 1 to 3 p.m.

The Piagetian-based laboratory experiments were developed and conducted by faculty from the departments of biology, chemistry, mathematics and computer science, and physics. Each was three hours in length and organized in a "learning cycle" format (Karplus, 1974) with exploration, invention, and application phases. The exercises in the various academic areas were designed to stress jointly, one per week, the following components of the

general problem-solving process: control of variables, proportional reasoning, combinatorics, probability, and correlation. Lincoln (1978) describes this component in detail.

The remainder of this article is devoted to the second component, which is designed to increase critical reading/analytical reasoning ability with emphasis on performance on standardized reading and scholastic aptitude exams.

Cognitive process instruction

Monday through Thursday afternoons, students spent one and a half hours solving comprehension and reasoning problems (both verbal and mathematical), and half an hour studying vocabulary. On Friday of each week they engaged in team competitions in problem-solving and vocabulary. This aspect of the program will be described later.

The problem-solving and vocabulary classes were conducted by former Xavier students who were on campus for the summer, but who attended various medical schools during the academic year. This component was developed by the authors of this article. For the first three and a half weeks of problem-solving, the classes used a workbook entitled *Problem-Solving and Comprehension* (Whimbey and Lochhead, 1979), which contains analytical reading and reasoning problems such as the following:

1. Cross out the letter after the letter in the word *pardon* which is in the same position in the word as it is in the alphabet.
2. Oven is to bake as ____ is to ____.
   a. vacuum cleaner : rug
   b. automobile : carry
   c. food : ice
   d. dishwater : dishes

The workbook uses a special pedagogy (cognitive process instruction) involving thinking aloud. The process was explained to the students as follows (Whimbey and Lochhead, 1979, p. 27):

> The ability to analyze complex material and solve problems is a skill—just like any other skill such as the ability to play golf or the ability to drive an automobile. However, there is a peculiar difficulty involved in teaching analytical skill. Generally there are two phases to teaching a skill. First the skill is demonstrated to the student. Then he is guided and corrected as he practices it. For example, golf is taught by showing the beginner how to grasp the club, how to place his feet, how to move his arms and his body as he swings. The beginner can watch a golf pro—he can even watch a slow motion film of the pro in action—and in this way can learn the pro's techniques. Furthermore, the pro can observe the beginner as he practices, he can point out his flaws, and he can show him how to improve.
>
> In contrast to playing golf, analyzing complex material is an activity which is generally done inside your head. This makes it somewhat difficult for a teacher to teach and for a learner to learn. In other words, a beginner cannot observe how an expert thinks and solves problems. And the expert has trouble demonstrating his technique to a beginning student. There is one way to reduce this difficulty: have people think aloud while they solve problems, i.e. have both students and experts vocalize their thoughts as they work through complex ideas and relationships. In this way the steps that they take are open to view; their activities can be observed and communicated.
>
> In this book, the procedure of asking people to think aloud while they solve problems is applied in two ways. Experienced problem solvers (a group of graduate students and professors) were asked to think aloud as they solved the problems that are presented in the book. The responses were tape-recorded and then the steps they took in solving a problem were summarized and written out. These summaries are presented under the heading Problem Solution. In other words, the problem solution which follows each problem is a summary of steps taken by an experienced problem solver as he or she worked the problem aloud.
>
> The second application of the procedures consists in asking you, the reader, to think aloud as you work each of the problems. In doing this, you make your thinking visible to the other students so that they can observe your attack on a problem. Thus, they can learn the techniques you use, they can help point out any errors you make, and they can compare the steps you take with the steps listed in the problem solution. Furthermore, you will find that by thinking aloud you will be able to look at your own thinking activities more carefully. You will be able to see exactly what strategies you use, and what difficulties you have in solving a problem.

The SOAR students were then shown several "thinking aloud" responses from academically successful people to demonstrate how they analyzed similar information presented in written form.

Following this introduction, students were instructed to apply the process by working in pairs (a "problem-solver" and a "listener"), taking turns thinking aloud as they solved a series of assigned problems. The listener was instructed to pay close attention to make certain that the problem-solver proceeded in a careful, step-by-step manner—the major characteristic of the individual who is good at critical reading/analytical reasoning—as evidenced by constant verbalization of his or her thought processes. In addition, individual students were asked to explain to the entire class their solution to particularly difficult problems.

As noted above, the text, *Problem-*

Solving and Comprehension, was used for three and a half of the five weeks. In the last one and a half weeks students continued to work in pairs and think aloud (i.e., to use cognitive process instruction) as they answered reading comprehension and sentence completion exercises from the following sources: *Breaking the Reading Barrier* (Gilbert, 1959), *Dental Admission Test Preparation Materials* (American Dental Association, 1977), *Graduate Record Examination Information Bulletin 1978-79* (Educational Testing Service, 1978), *Taking the SAT* (College Entrance Examination Board, 1978), and *Six-Way Paragraphs* (Pauk, 1974).

To supplement this training in reading and problem-solving, students spent half an hour per day on Monday through Thursday for the entire five weeks studying vocabulary from *Vocabulary for the College-Bound Student* (Levine, 1965).

Quiz bowl competition

On Friday afternoon of each week, there was a "Quiz Bowl Competition" in which the five groups competed against each other. The Quiz Bowl had three components, each based on the problem-solving/comprehension and vocabulary materials covered that week. They were: 1) a written problem-solving and comprehension test; 2) a written vocabulary test, including sentence completion, recognition of antonyms/synonyms, and analogies; and 3) an oral, "quick answer" vocabulary quiz in which each group was represented by four students (with restrictions on the number of repeat appearances). The weekly group winner was determined and announced with fanfare immediately upon completion of the three components by combining scores so that written performance was the primary determinant of the winning group. Individuals who performed well on the written exams were given recognition the following class period in a special biweekly newsletter.

These competitions generated strong enthusiasm and group cohesiveness. Students were regularly seen studying vocabulary or problem-solving during the lunch hour or other spare moments. In addition, students having difficulty with either written component actively sought tutoring so as not to pull down their team's score, and those who had done well in a particular area willingly served as tutors for their teammates. Further, special tutoring sessions established for weaker students outside of regular hours were well attended even though attendance was not required. While individual competition may be ill-advised in some educational settings, the team competition in SOAR was obviously of tremendous benefit in getting the students to study subjects (vocabulary and critical reading) which some might otherwise have found dull.

Program evaluation

The program was extremely successful. The students reported on a questionnaire that they had learned a great deal as a participant in SOAR and that they would recommend it highly to other science students contemplating enrolling at the university. In addition, SOAR participants made significant gains over the five weeks on an instrument designed to measure Piaget's levels of intellectual development (Lawson, 1978), a standardized reading exam (The Nelson-Denny Reading Test), and a recognized measure of ability to perform in college (the PSAT). An analysis of the first of these (Piaget's levels) was summarized in the *Change* article (Lincoln, 1978). The latter two are described in more detail below.

Pre and posttest comparisons for scores on both the comprehension and vocabulary portions of The Nelson-Denny Reading Test (Form C for the pretest, Form D for the posttest) for various subgroups are given in the Table. The entire group could not be used because many of the better students scored so high that their scores had no validity. The data in the Table indicate that the average increase in level of performance on the comprehension portion of the Nelson-Denny ranged from 1.4 grade levels for those participants who scored less than or equal to the 12th grade level on the pretest to a high of 2.3 grade levels for those who scored less than or equal to the 10th grade level at the beginning of the program. Further, increases on the comprehension portion of the exam were statistically significant beyond the 0.01 level. These dramatic gains in reading comprehension in a five-week program devoted to teaching analytical reasoning support the postion (taken by Thorndike, Farr, and others) of viewing critical reading as dependent on analytical reasoning skills and justify orienting a reading program accordingly.

Average grade level performance on The Nelson-Denny Reading Test for subgroups of 1979 SOAR participants with selected pretest scores

Grade level on pretest	Comprehension					Vocabulary				
	N*	Pre	Post	Change	p	N*	Pre	Post	Change	p
Score ≤12.0	34	9.9	11.3	1.4	<0.001	42	9.9	11.7	1.8	<0.001
Score ≤11.0	27	9.5	11.1	1.6	<0.001	34	9.6	11.5	1.9	<0.001
Score ≤10.0	18	8.9	11.2	2.3	<0.001	17	8.7	10.9	2.2	<0.001

*Number of students out of the total of 73 scoring at or below each grade level

The data in the Table for pre and posttest performance on the vocabulary portion of the Nelson-Denny indicate that the average increase in performance ranged from 1.8 grade levels (for those below or equal to the 12th grade level on the pretest) to 2.2 grade levels (for those below the 10th grade level). These increases, like those for comprehension, were statistically significant for all subgroups (using a *t* test) beyond the 0.001 level.

Finally, pre and posttest scores were determined for students on different versions of the PSAT (Preliminary Scholastic Aptitude Test). The 21 students with scores less than 70 at the beginning of the program (equivalent to Xavier's minimum SAT score for unconditional admission) gained an average of 11.4 points while the total group for whom pre and post scores were available (73 students) showed an average increase of 7.3 points. (The unexpected appearance of Hurricane Bob caused cancellation of one day of post-evaluation and consequently lowered the total number for whom data were available.) Both increases were statistically significant beyond the 0.001 level using a *t* test for comparison.

Since most educators at the college level are more familiar with the SAT than the PSAT, it might be of interest to note that the College Board has scaled PSAT scores in a 1.10 ratio with SAT scores. Thus, the average gains noted above would correspond to 114 points (for students less than 700 on the pretest) and 73 points (for the total group) on the SAT.

Cognitive process instruction as implemented in Project SOAR has resulted in statistically significant gains on both The Nelson-Denny Reading Test and the PSAT. Since available research indicates that significant SAT gains are generally followed by improved classroom performance (Marron, 1965), and since SOAR also produced significant gains on other measures (such as Lawson's test of formal reasoning), Xavier is now attempting to give students additional exposure to SOAR's "learning cycle" and "cognitive process" pedagogies by incorporating these methods into standard classes during the regular academic year. ■

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6th Biennial Conference on Chemical Education

Rochester Institute of Technology will host the 6th Biennial Conference on Chemical Education, June 22–26, 1981. The general chairman is Earl Krakower of RIT, and the program chairman is Leonard W. Fine, Hobart and William Colleges.

A program of 130 papers covering a wide variety of topics has been scheduled. Features of the program include plenary lectures by Moshe Lubin on "Fusion—an Energy Technology for Tomorrow" and Glenn T. Seaborg, whose presentation is titled "Our Energy Problem." Tuesday evening's conference banquet speaker is Hans Bethe, Cornell University, discussing "The Energy Problem and Nuclear Power." Other features of the program include a symposium entitled "The Art of the Lecture," with plenary lecture/demonstrations by H. E. Bent and H. A. Bent, D. Harpp of McGill University and R. Shakashiro, University of Wisconsin. The conference will be highlighted by evening "afterglow" sessions, exhibits, poster sessions, and CHEMathon-80 with appropriate T-shirts and prizes. In addition, a special seminar/workshop will be given on Computerized Infrared Spectroscopy.

On-site registration will take place at the National Technical Institute for the Deaf (on the RIT campus) beginning at 1 PM, Sunday, June 22. Registration is $60. Meal plan and dormitory accommodations are available at reasonable rates and must be arranged prior to June 6. For further details, contact Earl Krakower, Chemistry Department, Rochester Institute of Technology, Rochester, N.Y. 14623, or phone (716) 475-2497.

SUNDAY EVENING

L. W. Fine, Presiding

8:00—1. Fusion—an Energy Technology for Tomorrow. M. Lubin

MONDAY MORNING

Energy, Catalysis, and Coordination Chemistry

S. Kirschner, Presiding

8:45—2. Our Energy Problem. G. T. Seaborg
10:00—3. Organometallic Chemistry and Catalysis: Comparison of the Past, Present, and Future. R. Eisenberg
10:45—4. Some Recent Developments in Coordination Chemistry. S. Kirschner
11:20—5. Electronic Energy Transfer in Triplet States. A. Cabello, E. Enciso
11:40—6. Stoichiometry of the Pyrophoric Iron-Oxygen Reaction. E. W. Vitz
11:55—E. Patton, Commentator

MONDAY MORNING—A

M. P. Goodstein, Presiding

10:00—7. Use of Molecular Models in the Organic/Biochemistry Laboratory. S. J. Baum
10:29—8. Opinions on the Lecture. T. R. Wilderman, M. J. Pavelich, E. D. Sloan
10:40—9. Development of Classroom Video Capability for Undergraduate Education in Science and Engineering. W. T. Burnett, T. Baldwin, B. Sen, R. Spears
11:00—10. Teaching Units Controlled by Chemistry Models. Learning Materials and a Delivery System. D. W. Emerson
11:20—11. Math for Introductory Chemistry. A Place Value. M. P. Goodstein
11:40—12. Chemistry for the Deaf Program Status. S. Bunce, C. Allen

MONDAY MORNING—B

General

N. Sandberg, Presiding

10:00—13. Exploring Three Learning Dimensions for High School Chemistry. J. P. Rouse
10:20—14. Teaching Chemical Concepts through Imaging. T. S. Taylor
10:40—15. Use of Learning Cycles in Teaching Chemistry. L. S. Fowler
11:00—16. Exploring Cognitive Development in Upper Class Chemistry Courses. L. C. Lewis
11:20—17. Implications of Piaget in Physical Chemistry for the Teaching at High School and First Year College Chemistry. G. P. Rauch
11:40—18. Chemistry at Hampshire College: An Experimental Approach. L. G. Williams

MONDAY AFTERNOON

All Things Great and Small

G. Crosby, Presiding

2:00—19. Avogadro and the Concept of the Mole. G. Crosby
3:00—20. Physical Consequences of Scale. T. Dunn
3:55—W. J. Hayles, Commentator

Chemistry and the Handicapped

D. F. Cain, Presiding

2:00—21. Handicapped Scientists. M. R. Reagan
2:15—22. Taking Measurements: Systems for Aiding Blind Students in Undergraduate Chemistry Laboratories. D. Lunney, R. C. Marston, M. M. Cetera, R. V. Hastings, G. Lockitch, D. Sowell
2:55—23. Chemistry Laboratory Experiments for Blind Students. M. F. Richardson, W. Bazinet, M. Benkel, T. Bielnacki, T. Brindle, J. M. Miller
3:25—24. Teaching Chemistry to the Hearing Impaired. R. E. Cain

MONDAY AFTERNOON—A

General

D. F. Shriver, Presiding

2:00—25. A Missing Antibody. A. T. Schwartz
2:20—26. Teaching Chemistry Thinking Patterns: Rational and Irrational. K. E. Kent
2:40—27. Inclusion of Isotopic D. Kirk
2:55—28. [illegible] L. T. Pirkle
3:25—29. [illegible] R. C. Anderson
3:40—30. Teaching Laboratory Safety. W. E. Wolanowski

MONDAY AFTERNOON—B

General

H. M. Ball, Presiding

2:00—31. Experiences of Chemistry in High School Classes. M. C. Nagel
2:20—32. Computerization of Chemical & Technical Aspects of Training Programs. S. T. Marcus, J. H. Cullen
2:40—33. Guide to Using Topics in General Chemistry. P. K. Welty
3:00—34. Evaluation of the Impact that Exists for the Physics Texas Energy Program at Community College of the Air Force. R. D. Downing, F. C. Mooney, L. N. Davis
3:20—35. Chemistry in a Science Museum. V. A. Wilcox
3:40—36. [illegible] S. H. Dass

POSTER SESSION I

3:00-5:00 MONDAY AFTERNOON

37.—Interactive Computing in the Physical Sciences Laboratory. H. M. Ball
38.—Hands On Laboratory Experiments for Preparatory Chemistry. J. S. Copes
39.—Quantum Chemistry Experiment System. J. E. Ellers, B. D. Joshi
40.—Making Ancient Oils Chemistry Interesting. J. I. Gelder, R. E. Snelling, R. D. Koepp
41.—Increased Emphasis on Data Analysis in the Physical Chemistry Laboratory. E. Kelly
42.—Five Weeks Field Trip. Taking the Lab to the Laboratory. D. Maclennes Jr.
43.—Physical Chemistry Program for First-Year Students. T. L. Miller
44.—Physical Analysis of the Carbon Compound Pair of I.R. A. M. V. Orna
45.—Motivation Through Chemistry. Introductory Course for All Majors. L. Peck
46.—Teaching Experiments and Demonstrations. J. S. Todd, G. Rhodes
47.—Chemical Model for Chemical Bonding. L. J. Sacks
48.—Nebraska Instrument Sharing Consortium. D. H. Smith
49.—Synthesis of Diethyl Ether. An Experiment in Organic Chemistry with an Industrial Emphasis. D. Tanguiden, T. Yates
50.—Project TEAM (Tutor Model). T. J. Tipton, D. W. Bindes
51.—Space Filling Models. D. Halsted
Limit 50 Participants at $30

MONDAY EVENING

D. N. Harpp, Presiding

52.—Magic of Chemistry. J. Schwarcz, A. Fenster

TUESDAY MORNING

Art of the Lecture

H. A. Bent, Presiding

8:10—53. Affective Dimensions of the Physical Chemistry Laboratory. H. A. Bent, H. E. Bent
10:00—54. Aspects of Symmetry. D. N. Harpp
11:00—55. [illegible] B. Shakashiri, G. Dixon
11:55—A. T. Schwartz, Commentator

TUESDAY AFTERNOON

Women and Minorities in Chemistry

J. Chapman, Presiding

2:00—56. [illegible] A. Anderson, J. W. Carmichael
2:15—57. [illegible] Keen, C. Middlecamp
3:05—58. [illegible] Wells, J. W. Carmichael Jr.
3:25—59. [illegible] Wells, Sr. J. Bauer, B. Wells, J. W. Carmichael Jr.
3:45—60. [illegible] Wells, Sr. J. Bauer, J. W. Carmichael Jr.
4:05—61. Analysis of Women in Graduate School. A. A. Russell
4:25—62. Women Chemists: Toward a Consistent Professional Career. N. M. Roschar
4:55—J. Lagowski, Commentator

TUESDAY AFTERNOON—A

General

T. C. Morrill, Presiding

2:00—63. Communicating Descriptive Chemistry with a Computer. K. J. Johnson
2:20—64. Preparation for Chemistry—a Testing Course with Computer-Aided CAI Programs. J. W. Beatty, E. S. Scott
2:40—65. Computer Program for the Facile Construction of Problem Sets Containing Different Numerical Values for Each Student. J. R. Hutchinson
3:00—66. Modernizing the Pursuit Laboratory Data System. D. Travis, T. Green, S. S. Owen
3:20—67. Applications of EDB in Chemistry. (1) Annotated List of Laboratory Experiments from Journal of Chemical Education with Computer Access. (2) Computer-Assisted Report Grading. (3) Socrates, an Inquiry-Based Technique in Problem Solving. C. Allen, S. Bunce, J. Zubrick
3:40—68. Analytical Chemistry—Special Application for Surface and Ground Water Studies. S. E. Wenger

TUESDAY AFTERNOON—B

General

E. Patton, Presiding

2:00—69. Teaching Descriptive Chemistry with Computer Programs. J. D. Hinsteitler
2:20—70. Amperometric Determination of Phenol Preservatives. R. Cohen, C. Matzek, S. Schlosser, C. O. Huber
2:40—71. General Behavior of the Salt-Absorption. J. A. Duenas Fananas, A. Cabello
3:00—72. Concepts and Mechanisms for Redox Reactions. G. P. Haight, R. Scott

TUESDAY AFTERNOON—C

General

K. Hanzal, Presiding

2:00—73. Program for Increasing Faculty Awareness of Purposes and Theories in Education. E. D. Sloan, T. R. Wilderman, M. J. Pavelich
2:20—74. Art of Asking Questions in the Lecture Classroom Approach to Enhancing Higher Level Thinking. M. J. Pavelich, T. W. Williaman, E. D. Sloan
2:40—75. Communicating Science: Some Problems with the Language. M. McClintock, G. Rhodes
3:00—76. Communications That Captivate. A. K. Indikayan
3:20—77. Computer Aided Laboratory. The [illegible] Science Laboratory Experiments Using the Computer. F. W. Zurer
3:50—78. Recent Advances in the Periodic Table. J. F. Eik
4:05—79. A New Teaching Laser. M. C. Hidalgo
4:20—[illegible] Laboratory Program Through Technology Experience. J. The Society and the Schools. S. Ware

POSTER SESSION II

3:00—5:00 TUESDAY AFTERNOON

80.—Property Losses Least But Also Costly Disinterest. R. K. Berry

New Chemistry from the ACS Advances in Chemistry Series

No. 184 Interfacial Photoprocesses: Energy Conversion and Synthesis, *Mark S. Wrighton, Editor.* 315 pages (1980) Cloth $41.00

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81.—Fred Russell Apology—The Mole Hole, Bridge and Other Excursions into the Art, Science, Habit. W. Bleam Jr.

82.—Development of Versatile Video Capability for Undergraduate Education in Science and Engineering. W. T. Burnett, T. Baldwin, B. Sen, R. Spears.

83.—Chemistry Textbook Evaluation. S. Gannaway.

84.—Use of a Pocket Alarmist for the Emission Flame Test. E. Henderson.

85.—Videotaped Library of Individually Accessed Lecture Demonstrations. L. L. Jones.

86.—Hybrid Stereomodels. G. O. Larson.

87.—Integrated Organic and Biochemistry Allied Health Course. C. E. Ophardt.

88.—Instructional Materials for Commuter Students. J. L. Sarquis.

89.—Analytical Chemistry in High School. E. L. Schultz.

90.—Overhead to the Communication of Crystallography—A Jointly Taught Course in Symmetry. D. M. Thompson.

91.—Organization and Implementation of a Cooperative Education Program in Chemistry. Y. S. Yamamoto.

3:00-5:00 TUESDAY AFTERNOON

Workshop

92.—Polarize Conductivity Meter. G. Sparrow.
Limit 15 Participants — $10

TUESDAY EVENING

Conference Banquet

M. Lubin, *Presiding*

93.—Energy Problem and Nuclear Power. H. Bethe

WEDNESDAY MORNING

B. Shukhashin, *Presiding*

8:30—94. Early Contributions of the Pioneer Women Chemists. D. A. Dexenport

Aspects of Toxicology

W. N. Piglet, *Presiding*

10:00—95. Mechanisms in Toxicology. F. L. Scott

10:45—96. Meaning of Mutagenesis. A. Tomelsko

11:30—W. N. Bigler, *Commentator*

WEDNESDAY MORNING—A

General

D. N. Hupp, *Presiding*

10:00—97. [illegible] G. M. Bodner, A. R. Robinson

10:20—98. [illegible] W. E. Coleman

10:40—99. Teaching Descriptive Inorganic Chemistry: How, When, and Why. R. W. Collins

11:00—100. [illegible] A. Bayer

WEDNESDAY MORNING—B

A. M. Sargus, *Presiding*

10:00—102. [illegible] J. B. Heiron

10:20—103. [illegible] D. A. Katz

10:40—104. [illegible] M. Gottlieb

11:00—105. [illegible] H. G. Friedman

11:20—106. [illegible] A. M. Sargus

11:40—107. [illegible] A. M. Sargus

WEDNESDAY AFTERNOON

E. L. Wagner, *Presiding*

1:30—108. [illegible] S. A. F. Young

WEDNESDAY AFTERNOON—A

General

G. Stevens, *Presiding*

3:00—109. Expecting a Dismissal: Reactions, Emotions, Expectations, Relationships, Ethics, Preparation, Help. J. A. Campbell, Secondary School Counselor, D. R. Wenrich

3:20—110. Laboratory Skills Evaluation. G. G. Hicking

3:40—111. [illegible] M. Kolr, L. J. Nicholls

4:00—112. [illegible] Agnes Angelis, D. I. Lewis

4:20—113. [illegible] M. McKone

4:40—114. Evaluating Chemical Abstracts. R. Bayer

WEDNESDAY AFTERNOON—B

General

D. Evans, *Presiding*

3:00—115. [illegible] B. Stewart

3:20—116. [illegible] J. E. White

3:40—117. [illegible] E. T. Kelliod

4:00—118. [illegible] E. E. Stanislaski

4:20—119. [illegible] R. Bianchetta, M. Haxilak, J. Tanaka

4:40—120. [illegible] M. Taylor, M. Sargus

5:00—121. [illegible] Haleh

WEDNESDAY AFTERNOON—C

General

S. Kare, *Presiding*

3:00—122. Teaching Essential Concepts in the 11th-12th High School Chemistry Course. D. A. Haisted

3:20—123. We Can't Fix a Crime-Solving Lab for Maintenance Students in Chemistry. J. A. Harris

3:40—124. [illegible] M. B. Anderson

4:00—125. A Problem? An Example of the Perception of Chemical Research by the Technological Student. H. Bassow

4:20—126. Science Achievement Scholastic Attitude and Test Scores as Predictors of Success in the Science Content of Introductory Courses in Ordinary Level Chemistry and Physics of Pupils in Sierra Leone, West Africa. A. B. Johnson

WEDNESDAY EVENING

L. W. Fine, *Presiding*

127. [illegible] Morris A. Mc Cully, Commander, Naval Supply Corps, and Eric Percival, Chemistry. W. Burrows

P. Morgan, *Commentator*

THURSDAY MORNING

I. Dalton, *Presiding*

8:50—CHEMATHON 85
10:00—[illegible]

Conclusions

I. Stoddart, *Presiding*

11:00—128. [illegible] Eric Percival, F. R. S. E. Patton

12:00—29. Retrospective [illegible] E. Rightmire, L. Fine, G. Stevens, A. T. Schwartz, D. Eubanks, D. Kalus

Education

Educators discuss teaching the handicapped

Chemical education meeting emphasizes methods for communicating chemistry to physically handicapped, women, and minorities

Ward Worthy
C&EN, Chicago

"Communicating chemistry" is really what chemical education is all about. But according to some participants at the Sixth Biennial Chemical Education Conference, the chemical education establishment hasn't been doing so well as it should in communicating it to several important parts of society, including the physically handicapped, women, and members of minority groups.

"Communicating chemistry" was the theme of the conference. Sponsored by the American Chemical Society's Division of Chemical Education, it was held late last month at Rochester Institute of Technology.

There was something for everybody. RIT's Karl Krakower, the conference chairman, noted that the 450 or so participants could choose from among more than 100 different "events." Noted scientists reviewed important current topics in chemistry and related fields. "How-to-do-it" sessions and workshops taught new tricks in the use of demonstrations, molecular models, and audiovisual aids. Many of the presentations were aimed at high school chemistry teachers (about 80 attended), a group that had been somewhat neglected at previous conferences.

It wasn't all work. A "chemical magic" show proved that bleach chemistry pros can enjoy clock reactions, water into wine, and explosions just about as much as freshman chemistry students do. For masochists, there was "CHEMathon '80" with 2-, 5-, and 10-km runs held, fortunately, on the last day of the meeting.

However, the special challenge of communicating chemistry to the physically handicapped was put in sharp focus by the conference's being held at the facilities of the National Technical Institute for the Deaf. That federally supported school is also one of the colleges of RIT; many of its students are "cross-registered" at other RIT colleges.

At all the plenary lectures and also at many of the smaller specialized sessions, the speakers' words were "signed" by skilled interpreters from the NTID staff. One could only marvel at the speed and apparent ease with which these interpreters spelled out complicated chemical terms, and at the clever imagery of the ideographic gestures used for the more common words and concepts. In fact, there was occasionally a suspicion that the interpreter's version was more interesting than the speaker's.

At one session dealing specifically with communicating chemistry to the handicapped, Martha Ross Redden of St. Peter's College, Jersey City, described her experiences with the American Association for the Advancement of Science's "project on the handicapped in science." One of the fruits of that project was the first "accessible" AAAS meeting, held in Boston in 1976. Some 200 disabled scientists attended. Ramps made it easier for those confined to wheelchairs to get around. A "resource center" provided oral or manual interpreters for the blind or deaf.

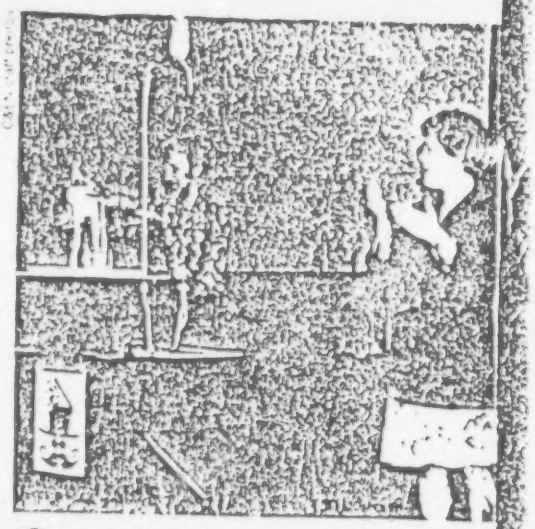
Perhaps the most important thing she and her coworkers learned in that experience, Redden says, is "Don't take anything for granted." The way to find out what needs to be done is to ask disabled scientists and students. Typically, disabled people don't expect that kind of concern and usually won't ask for special assistance, she says. However, when AAAS asked disabled scientists to identify themselves and to state their problems and their "coping strategies," some 700 did so very quickly. One result of that effort has been a "Directory of Disabled Scientists," listing people who are willing to advise and assist in promoting the education of young handicapped scientists.

Obviously, different handicaps present different challenges. Forexample, says Robert C. Morrison of East Carolina University, Greenville, N.C., when Richard V. Hartness, a blind student, enrolled in general chemistry there, the lecture part of the course didn't pose too many problems. But the laboratory portion did. "Surprisingly (or not) there were a number of people who didn't want a blind student in their lab," Morrison says.

Hartness was assigned to a lab section, just the same. The question then became one of how to do it. A sighted assistant was "totally inadequate," Morrison says. The assistant did too much of the work and didn't allow Hartness to make mistakes. It was important that he have as much independence in the lab as possible.

A search of the market revealed that almost nothing in the way of laboratory teaching aids for blind students was commercially available. So Morrison, fellow professor David Lunney, and their East Carolina coworkers set out to build one.

The result has been dubbed ULTRA, for Universal Laboratory Training and Research Aid. ULTRA is a talking microcomputer system that can be interfaced to several laboratory instruments, including pH meters and spectrometers. The microcomputer takes signals that normally would go to a meter or a chart recorder and, using phonetic codes and a voice synthesizer, converts them to spoken words. The thing talks funny, but it can be understood after a little practice. In addition,



"Chemical magic" show was "signed" by skilled interpreter from NTID staff

some phenomena, such as end points in titrations, can be followed by listening to changes in the pitch of a continuous tone.

Several computer programs have been written to aid blind students with undergraduate experiments. Also, a talking calculator program has been developed, so that the student can perform calculations using the experimental data collected. Morrison notes that the student is in complete control of the experiment; the computer won't do anything unless the student gives the appropriate command. However, the student can ask the computer for help if he or she isn't sure which command should be given next.

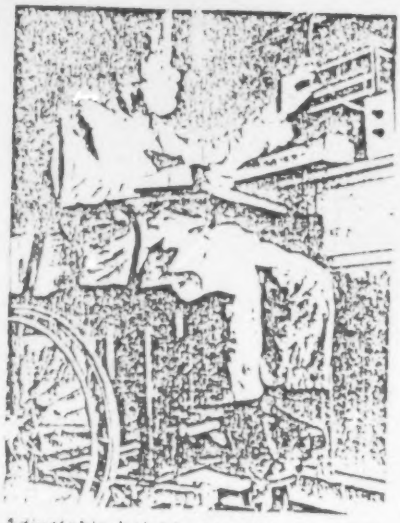
Morrison says the ULTRA prototype originally cost about $2000. Now, with "added stuff," it runs about $7000 or $8000.

In the case of hearing impaired students, very few adaptations are needed for laboratory work, but a variety is needed for the classroom, says B. Edward Cain of the NTID chemistry staff. Usually, these must be tailored to the individual student. For some, special hearing aids are enough. But the more profoundly deaf must acquire all their information by visual means. This may require the use of an interpreter and will usually place some restrictions on the instructor's normal mode of presentation.

For example, Cain says, "Don't talk to the blackboard." Also, remember that a deaf person has to concentrate on the speaker's lips or the interpreter's hands at all times. Consequently it's hard for him to "listen" and take notes at the same time. At NTID, note-takers are provided when needed. Sometimes, students with normal hearing will make copies of their own notes to share with deaf students. Some professors provide copies of their lecture notes.

"Media" pose problems too, Cain points out. When the lights go off and the projector goes on, the deaf can lose communication even if an interpreter is present. In fact, that happened during that very session. The difficulty was solved with a small portable spotlight that illuminated the interpreter's hands without making the room too bright to see the pictures on the screen.

During demonstrations Cain says, the deaf student has to look at the demonstration and the interpreter at the same time. So it's helpful to describe what's to be done before doing it. Class involvement is important, but the interpreter is always a few words behind the instructor. So when the instructor says "Does anyone know ..." or "Any questions?" he should pause a bit before moving on with his presentation.



Adjustable-height wheelchair allows Brock University's Balenovich access to all kinds of equipment

As to the safety of deaf students in the laboratory, "there is no reason to worry," Cain says. He notes that the buddy system, in which one student looks out for another, is "cheap, free, and appropriate for all students." Also, it doesn't cost much to add flashing lights to audio alarms. But since the hearing-impaired student gets all his information via his eyes, "Eye protection is most important. You can't be too strict about goggles."

Chemistry students in wheelchairs, like Walt Balenovich of Brock University, St. Catharines, Ont., have a different set of problems. Sometimes, it turns out, simple solutions are better than more complicated ones. For example, says Brock chemistry professor Mary F. Richardson, the first approach was to build a low, portable lab bay. But that approach was abandoned. It limited the student to an artificial workplace, one that couldn't be duplicated for many types of equipment that a practicing scientist must use.

"To allow access to all kinds of equipment, normal-height desks, recessed shelves and so on, we built an adjustable-height wheelchair out of discarded wheelchair wheels, a used hydraulic truck jack, and the seat and back of an office chair, for about $500," Richardson says. With the special wheelchair, which he helped design, Balenovich can carry on research in the chemistry department without the need for other special considerations. Such a chair, Richardson adds, "should be a big plus when the student seeks employment, as the employer wouldn't have to modify the height of benches and equipment to accommodate a handicapped employee." She notes that an improved model, with a scissors jack and a higher "lift," is now under development.

Not all handicaps are physical. If one judges by the number of people in the field, just being a woman or a black has been, and apparently still is, a handicap to a career in chemistry. At a session on communicating chemistry to women and minorities, a trio of chemistry teachers from Xavier University, New Orleans, described a program that has had remarkable success in bringing science to the students at that small, Catholic, predominantly black school.

For example, JW Carmichael Jr. noted that chemistry faculty members are rightly concerned with maintaining high academic standards. Most also recognize the need to make science careers more accessible to women and minorities. Few seem to realize that it's possible to do both: to maintain high standards and also support special programs for special students. As a result, Carmichael maintains, chemistry has fallen far short of its potential in the effort to increase the representation of women and minorities.

What is needed, Carmichael says, is "standards with sympathy," with more emphasis placed on exit criteria than on entrance criteria. First, of course, it's necessary to get the students, and Xavier has an aggressive recruiting campaign. For example, it holds "math/science rallies" to promote science careers among minority high school students.

Prefreshman science majors are invited to attend a special summer program, SOAR (Stress on Analytical Reasoning), to improve their problem-solving skills. However, there is no "prep" chemistry course to precede the traditional entry-level general course. Instead, according to Xavier's Joanne Bauer and Barbara Wells, "support mechanisms" are built into the regular entry-level course in such a way that both the well prepared and the educationally disadvantaged have reasonable chances of succeeding.

These mechanisms include weekly problem-solving sessions that stress both chemistry and problem solving in general, a complete set of color-coded taped lectures, and review of math as needed. Also, the Xavier chemists note, the program aims to teach learning and study skills within the chemistry sequence itself. In addition, a coordinated, Piagetian-based laboratory program is designed not only to teach students how to do experiments but also to promote their general intellectual development. □

Appendix XXIX--Overview of Presentation by Dr. DuRapau

ENTRY-LEVEL MATHEMATICS COURSES FOR MINORITY STUDENTS

A Short Communication

presented to the

Fourth International Congress on Mathematical Education

by

Dr. V. J. DuRapau, Jr.
Dept. of Mathematics & Computer Science
Xavier University of Louisiana
New Orleans, LA 70125 USA

OVERVIEW OF XAVIER UNIVERSITY

Xavier University is the only predominantely black Catholic university in the Western Hemisphere, although 85% of its faculty and administration is composed of laymen and one-third of the students are non-Catholic. The University has an enrollment of over 1800 students, who come from 30 states and 10 foreign countries. However, two-thirds of the students live in the greater New Orleans area.

Xavier's primary mission is to provide educational opportunities to Black Americans, with emphasis on residents of the Gulf South. Xavier's institutional philosophy might be summarized as *standards with sympathy*, i.e., a commitment to accept many students with discernible academic weaknesses, coupled with an equally strong commitment to demand a high standard of performance for graduation. It is possible to do both simultaneously only because the University provides extensive support services, especially at the freshman level.

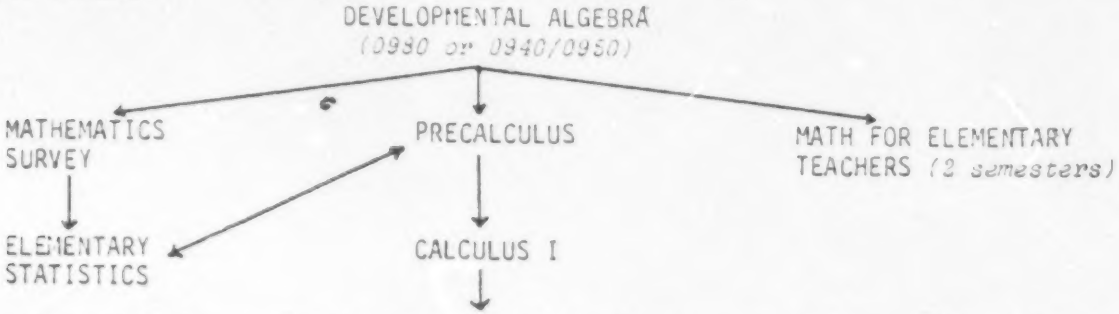
OVERVIEW OF THE *CAUSE* GRANT

In 1977, Xavier became the first predominantly-black institution to receive funds from the National Science Foundation's highly competitive CAUSE (Comprehensive Assistance to Undergraduate Science Education) Program. The primary objective of Xavier's project (CAUSE Grant SER77-06227) was to initiate a multi-departmental effort by the Departments of Biology, Chemistry, Mathematics/Computer Science, and Physics to reduce attrition from and to increase performance in entry-level science and mathematics courses as a means of increasing the number of students who ultimately graduate in the sciences. The four departments established a common set of basic strategies to achieve this objective.

XAVIER'S ENTRY-LEVEL MATHEMATICS PROGRAM

All students entering Xavier are required to take a locally-produced Mathematics Placement Examination which determines whether the student must complete a developmental, non-degree credit mathematics sequence (either the

one-semester MATH 0980 or the two-semester MATH 0940/0950 for those needing stronger remediation) before enrolling in regular college courses. The tree diagram displays possible tracks:



The CAUSE Grant focuses on improvement of the two college-credit mathematics courses taken by most science majors after passing either the Placement Exam or the developmental algebra sequence, i.e., Precalculus and Calculus I. Precalculus is a combination of elements from algebra and trigonometry. The Calculus I course is both a terminal course for most science majors and the first semester of a three-semester sequence for a much smaller number of students. Development of these courses under CAUSE has been accompanied with corresponding development (financed through other sources) of both the developmental courses and the remaining two courses in the Calculus sequence. The CAUSE Grant provided for the development in Precalculus and Calculus I of

(1) an effective and efficient tutoring system which is housed in the APLC (Alternate Pathway Learning Center) in Xavier's library;
(2) handbooks containing
    (a) learning objectives for each module,
    (b) sample problems to match each objective with space to work them in the handbook,
    (c) sample tests for each module with detailed solution keys,
    (d) supplements when material is lacking in the text,
    (e) six modules in each of the two courses;
(3) audio tapes to accompany each of the twelve modules. These tapes were placed in the APLC along with additional, commercially-produced audio-visual aids.

EVALUATION OF THE MATHEMATICS SEGMENT OF XAVIER'S *CAUSE* PROGRAM

It is unlikely that a science or mathematics major who makes lower than a "C" in a science or mathematics course will be able to successfully pursue a career in one of these areas. For that reason, the percentage of students who complete entry-level courses with a "C" or better is a suitable measure of success in the courses. The following table contains some statistics from the Precalculus and Calculus I sequence at Xavier for the past three years.

	SEMESTER	NO. ENROLLED	NO. (%) WITH "C" OR BETTER
PRECALCULUS	Fall '77 *	155	56 (36%)
	Fall '78	215	97 (45%)
	Fall '79	181	103 (57%)
CALCULUS I	Spring '78 *	107	50 (47%)
	Spring '79	117	73 (62%)
	Spring '80	133	68 (51%)

* Before implementation of CAUSE-developed materials

These and other statistics suggest a reduction in attrition from and an increase in performance in entry-level mathematics courses. This result is the major objective of Xavier's CAUSE project.

Appendix XXY--
PERSONS REQUESTING INFO ON CAUSE

NAME	POSITION	INSTITUTION	REQ'D INFO	PURCH'D MAT	VISITED XU
David O. Dickerson	Vice President for Academic	Seattle Pacific University Seattle, WA	X		
Timothy A. O'Shea	Associate Professor of Chemistry	Texas Wesleyan College Fort Worth, TX	X		
Shelton E. Stewart	Professor of Biology	Lander College Greenwood, SC	X		
Kay M. Elsen	Associate Professor of Chemistry	Mount Mary College Milwaukee, WI	X		
Robert Silberman	Department of Physics and Astronomy	University of Nebraska Lincoln, NB	X		
Wesley Lingren	Professor of Chemistry	Seattle Pacific University Seattle, WA	X		
Donald Zebolsky	Chairman, Dept. of Chemistry	Creighton University Omaha, NB	X		
Betty Dotson	Project Director of Right-to-Read	Indianapolis Public Schools Indianapolis, IN	X		
H. David Snyder	Department of Physics	Gallaudet College Kendall Green, DC	X		
Clara Watnick	Chairperson, Physical Sciences Cept.	Hostos Community College Bronx, NY	X		
Dennis Staley	Instructor, Academic Resource Center	Southern Illinois University Edwardsville, IL	X		
Scott Hoversten	Instructor of Chemistry	US Air Force Academy Colorado	X		
Morton Friedman	Professor and Head Instructional Research and Evaluation	University of California Los Angeles, CA	X		
Richard Hutchinson	Director, Institute for Cognitive Studies	Manhattan Community College New York, NY	X		
Jerome Lebkob	Chairman, Dept. of Chemistry	Iona College, New Rochelle, NY	X		
William Wasserman	Instructor, Chemistry	Seattle Central Community College, Seattle, WA	X		
Ann Barbul	Acting Director, Center for Health Careers Services	Morgan State University Baltimore, MD	X		
Stephen Main	Associate Professor of Biology	Wartburg College Waverly, IA	X		
Anthony Digenakis		Delaware Technical and Community College Newark, Delaware	X		

(continued)

Appendix XXX (continued)

PERSONS REQUESTING INFO ON CAUSE

NAME	POSITION	INSTITUTION	REQ'D INFO	PURCH'D MAT	VISITED XU
Mike Slaubuagh	Chemistry Instructor	Weber State College Ogden, Utah	X		
Robert Burge	Chemistry Instructor	Suffolk Comm. College Selden, NY	X		
Lee Kleiss	Chemistry Instructor	Fayetteville State U. Fayetteville, NC	X	X	
M.D. Bishop	Chemistry Instructor	Clemson University Clemson, SC	X		
Van Crawford	Chemistry Instructor	Mercer University Macon, GA	X		
Linda Fowler	Chemsitry Instructor	Cincinnati, OH	X		
Lucy Pryde	Chemistry Instructor	SW College Chula Vista, CA	X		
Bruce Murrey	Chemistry Instructor	U. of Wiscomsin-RF River Falls, WS	X		
T. Lang	Chemistry Instructor	Nazareth College Rochester, NY	X		
Jane Copers	Chemistry Instructor	Hamline University St. Paul, MN	X		
Sr. Mary Bryan	Chemistry Instructor	Rosemont College Rosemont, PA	X		
Barbara Lorenzo	Chemistry Instructor	John Abbott College St. Anne de Bellevue, Canada	X		
Jeanne Lagowski	Chemistry Instructor	University of Texas Austin, TX	X		
William Stratton	Chemistry Instructor	Earlham College Richmond, IN	X	X	
Kathleen Davis	Chemistry Instructor	Delaware State College Dover, Delaware	X	X	
Allen Hanson	Chemistry Instructor	St. Olaf College Northfield, MN	X		
Roger Festa	Chemistry Instructor	Norwalk Board of Ed. East Norwalk, CT	X		
Rita Murphy	Chemistry Instructor	Malden, MA	X		
Joan Sabourin	Chemistry Instructor	Delta College Michigan	X		
Betty Derrick	Chemistry Instructor	Valdosta State College Valdosta, GA	X		
Marlene Kolz	Chemistry Instructor	U. of Illinois-CC Chicago, IL	X		
Charles Kenyon	Cooperative Learning Center	SE Mass. Univ., N. Dartmount, MA	x		
Wilmer Stratton	Chemistry Department	Earlham College, Richmond, IN	X	X	

(continued)

Appendix XXX (continued)

PERSON REQUESTING INFORMATION ON CAUSE

Name	POSITION	INSTITUTION	REQ'D INFO	PURCH'D MAT	VISITED XU
Chairman	Chemistry Department	Oakland University Rochester, MI	X	X	